THURSDAY, SEPTEMBER 18, 1879

COLOUR-BLINDNESS

Colour-Blindness, its Dangers, and its Detection. By B. Joy Jeffries, A.M., M.D., Ophthalmic Surgeon. (Boston, America: 1879.)

SOME months ago the subject of colour-blindness was introduced into the columns of this periodical as bearing on a question of colour nomenclature. Little was then said on the subject itself beyond what was necessary to illustrate the point in dispute, but it may now be added that the general features of this remarkable defect of vision have lately been exciting much attention, and have given rise within the last few years to a somewhat extensive literature, involving points on which there has been much difference of opinion and some energetic controversy.

It is just a century since the first public announcement was made, through Dr. Priestley, of a case of defective vision, which, by the account left on record, we can easily recognise as being of the kind subsequently found so common. About twenty years later we come on the well known and often-quoted description of his own case, given by John Dalton, which, after another lapse of thirty years, was commented on by Sir John Herschel in a very lucid and instructive manner. This celebrated case has given rise to the name "Daltonism," by which the complaint is most generally designated by Continental writers, but which has been objected to by the English, on the ground that it is no compliment to their great chemist to associate his name with an unfortunate natural defect in his optical apparatus. Many other words, chiefly derived from the Greek, have been from time to time proposed, but the simple term *colour-blindness*, adopted generally by English writers, and its equivalent, *Farbenblindheit*, used by the Germans, appear to answer every purpose, and to be unobjectionable. For, whatever may be the special characteristics of the defect (and on this point there are differences of opinion), it is admitted on all hands that an inability to appreciate the sensation conveyed by some particular colour or colours to the normal eye must be its most distinguishing feature.

In 1840 appeared an essay by Prof. Elie Wartmann, of Lausanne; but the first complete work on the subject was the "Researches on Colour-Blindness," by Dr. George Wilson, of Edinburgh, published in 1855. After this several memoirs are to be found, chiefly in transactions or journals; but the subject attracted little notice beyond mere curiosity, till a few years ago, when oculists and physiologists suddenly woke up to a conviction that it had a real importance, both theoretical and practical, and therefore deserved more careful study than it had yet received. This movement appears to have originated in a more vivid appreciation of certain dangers that were considered likely to arise from the employment, in railway and marine service, of persons who were colour-blind, and were consequently liable to mistake coloured signals. This danger had been clearly pointed out by Prof. Wilson, but it had required many years for its importance to become recognised. When, however, attention was roused, there was no lack of persons ready to undertake the investigation of the subject, and a host of works have appeared by many men of eminence proposing means of providing against the evil; and although the inquiries have been instituted at first with chiefly a practical bearing, they have naturally, in the hands of scientific men, been mixed up with a good deal of speculation of a more theoretical kind. Among the workers who have busied themselves with the subject may be mentioned Prof. Holmgren, of Upsala, in Sweden; Dr. Stilling, oculist at Cassel; Dr. Magnus and Prof. Cohn, of Breslau; Prof. Donders, of Utrecht; Prof. Ewald Hering, of Prague; Dr. Daae, of Norway; Drs. de Wecker and Landolt, of Paris; and Professors Delbœuf and Spring, of Liege. Unfortunately, although we know that some of our most eminent oculists in England have also lately had the subject under their consideration, their researches have not yet been made public, and it is, therefore, opportune that we are able to announce the appearance of a work which, although not by an Englishman, is in our language, and will, therefore, make the English reading public acquainted with what has been done.

The author is ophthalmic surgeon to several hospitals; he is otherwise much connected with ophthalmological matters, and has had large experience in regard to colour-blindness. He gives a good and full account of the general nature and statistics of the defect, and the means he considers best calculated for its detection; enlarging on the necessity for a systematic testing of the vision of servants on railways and sea-going vessels, and recommending the rigid exclusion of those who have imperfect colour-vision. He further devotes some attention to matters of theory, adopting and advocating the views most generally entertained.

It is impossible, in the short space of such a notice as the present, to give any extended analysis of the recent comprehensive investigations; it must suffice to make a few remarks on some of the more prominent points of interest; and first as to the statistics. Dr. Jeffries has some interesting chapters on this head, and states that variable statistics have been given by different observers, depending largely on the mode of testing.

In regard to males, he gives a table of the results obtained by eleven different observers, who had examined on the aggregate about 50,000 persons, chiefly pupils in schools, *employés* on railways, soldiers, or sailors. The proportion of colour-blind persons was given variously from 3 to 6 per cent., the average being about 4. Assuming, therefore, the examinees to represent fairly the general population, we may take it for granted that one out of every twenty-five men we meet is deficient of any true ideas respecting the colours of objects he sees around him.

With females, the case is very different, the defect in that sex being exceedingly rare. Out of nearly 20,000 women and girls examined, there were only registered forty cases of colour-blindness, or 0·2 per cent.; and some of these are of doubtful accuracy. This is a very singular fact, for which no sufficient explanation has ever been suggested; it has indeed been remarked that women devote much more attention than men to colours in general, but this has no bearing on the question, inasmuch as the evil is not a functional derangement, which

might be brought right by exercise, but a natural and congenital defect of organic structure, altogether incapable of cure or even amelioration by any means at present known.

There is every reason to believe the defect is hereditary, and Dr. Jeffries gives some data as to its transmission, showing the curious law (not, however, without exceptions) that it is transmitted *through* the females, although the females themselves escape it, thus skipping over every other generation. For example, if a man is colour-blind he will have no colour-blind children, neither will any of his sons' sons be colour-blind, but the defect will probably be found among the sons of his daughters.

It has been asserted by some authorities that a higher percentage of cases exists among people of the Jewish faith, and an ingenious question has been raised whether this may not indicate a descent from an early general type of imperfect vision, so giving a sort of support to the Gladstonian theory of development of the colour-sense. But as the fact is disputed, it is useless to trouble ourselves about any inference from it.

Another point of interest is the mode of testing and examining the colour-blind, and a large portion of Dr Jeffries', as of all other late works, is devoted to this matter. There are two distinct objects in view in such examinations: first, simply to discover whether the examinee is or is not colour-blind; secondly to find out the precise nature of his sensations of colour.

The first is of the more practical importance, and it is aimed, of course, chiefly at the testing of railway servants and others who have to do with colours. I hold a strong opinion that too much alarm has been created about the danger of mistaking railway signals. Normal-eyed people (who have always the greatest difficulty in comprehending what the colour-blind really see) generally believe that because under certain circumstances a red and a green object give similar impressions to a Daltonian, therefore he must, under all circumstances, confound redness and greenness. Nothing can be further from the truth, and I may give my own experience with railway signals as an example. I have had a great deal to do with railways, and although there can be no doubt about my colour-blindness, I do not recollect that I ever experienced any difficulty in distinguishing a red lamp from a green one. They are always strongly contrasted to my eye, and often, when I have passed at night through Cannon Street Station, I have amused myself by watching the changes in the imposing array of signals exhibited there. I could give a sufficient explanation of this, but it would be out of place here. I believe, so far as my knowledge at present goes, that nearly all colour-blind patients see the distinction as well as I do; and this view is corroborated by the great fact that, although we may assume that down to a late period about one out of every twenty-five engine-drivers has been colour-blind, never since railways have been in use has a single accident occurred which has been positively attributable to the mistaking of a red for a green night signal. If the notions of the alarmists were well founded, we should have had collisions every day. At the same time I do not deny the possibility of danger, under certain circumstances, and I would by no means discourage the precautions proposed in the selection of men.

It is not so easy a matter to identify positively a case of colour-blindness as might at first be supposed. Mere inaccuracy in naming colours is not sufficient, for it often happens, on the one hand, that normal-eyed people name colours incorrectly, and, on the other hand, that colour-blind people will name many colours correctly. There have been several kinds of tests adopted by different examiners, but the most important are those by Holmgren, Schilling, and Daae. The first is the one recommended by Dr. Jeffries, and it is described by him at considerable length. The test is made with a large number of samples of worsted (or what we call Berlin-wool) of a great variety of colours and shades. A certain sample, of a pale but decided tint of green, is shown to the patient, who is desired to select from the heap all the specimens which, to his eye, match it in colour. If he is normal-eyed he will select only green samples, but if he is colour-blind he will add others of other colours, such as pink, light-brown, gray, &c., which, though so different to the normal-eyed, match the green tint to his defective vision. But the wools have to be carefully selected, and are expensive. Dr. Schilling's test consists of a set of lithographed coloured diagrams; he takes two colours which, though normally strongly contrasted, he knows appear alike to the colour-blind, say scarlet and yellow-brown, and he draws letters or patterns in one of these, on a ground of the other, *i.e.*, a scarlet pattern on a brown ground, or *vice versâ*, the design being so ingeniously arranged as to avoid betraying any lines of division. A single glance at these diagrams by a colour-blind person suffices to test his vision. If he is normal-eyed the patterns are visible to him; if he is colour-blind they are invisible, the whole diagram conveying to his mind the idea of one uniform colour.

Dr. Daae's test is a little page of samples of coloured worsted, arranged in rows. Some of the rows are devoted each to one colour, arranged in different tints and shades, while other rows contain different colours in the same row. If the patient is unable to distinguish between these two classes he is colour-blind.

All these tests are very simple, and appear to be efficient so far as the mere detection of the fact is concerned, which is all that is wanted for economic purposes.

But some of the investigators go farther; they prescribe other tests with a view to find out what is the nature of the patient's vision—to get an idea of what he actually sees. The arrangements proposed for this purpose are much more elaborate. Holmgren, for example, exhibits other samples of wool, and endeavours to infer the nature of the vision by observing what colours are considered to match it. Schilling has different sets of diagrams for what he considers different classes of the complaint, while many other contrivances, some of them extremely complicated, have been designed to test the vision by shadows, by coloured glasses, by reflected images; by polarisation, by contrast, by comparisons, and by the spectroscope. These are all more or less unsatisfactory, and the information hitherto obtained by them is worth very little. The answers of the patients are seldom trustworthy, and they are almost always interpreted by the examiner to suit some preconceived theory of his own. One of the most earnest and industrious investigators, Dr. Cohn, gives a long list of answers he has

received, but he has unfortunately vitiated his whole work by relying to a large extent on the naming of colours by the patients. This is the very worst and most fallacious test of all, and Dr. Jeffries quotes, in reference to it, the following forcible remarks by Helmholtz:—

"As to the examination of the colour-blind, simply asking them to name this or that colour will naturally elicit but very little, since they are then forced to apply the system of names adapted to normal perception to their own perception, for which it is not adapted. It is not only not adapted, because it contains too many names, but in the series of spectral colours *we* designate differences of tone [hue?] as such, which to the colour-blind are only variations of saturation or luminosity."

My own experience enables me thoroughly to corroborate this: if any one asks me to name a colour shown me, I tell him it would be as reasonable to treat me as a clairvoyant and to expect me to read the contents of a sealed envelope.

But these inquiries, as above stated, always have to do with the *theories* of colour-blindness, and a few words must be said on this point, which is one of great difficulty, and in regard to which the state of knowledge is at present exceedingly unsatisfactory. When Dalton wrote what may be considered the first good account of the defect, he, notwithstanding his great acuteness and his extraordinary powers of scientific investigation, failed to discover the important point of his case, namely, that he saw *two colours only*—yellow and blue. This was found out for him at a much later period by the penetration of Sir David Brewster and Sir John Herschel who designated the malady by the term, *dichromic vision*, which has ever since been used. Sir David Brewster, acting on this, framed a very simple explanation of the defect, founded on his own views as to the nature of colours. He had a theory that the solar spectrum was formed from three separate spectra overlapping each other, one giving red light, one yellow, and one blue, which might therefore be considered the three primitive colours for normal eyes, as it was taken for granted all other colours might be compounded from them. All that was necessary for the explanation of colour-blindness was to assume the eye of the patient insensible to the red rays, and the phenomena followed as a matter of course. This theory was a very plausible one, and is still in favour with many persons who have practically to do with colour. But unluckily on further examination it was found wanting, inasmuch as one of the main effects in it, namely, the supposed production of green by a mixture of yellow and blue, turned out to be a delusion; and moreover, as the theory of light became better known, the idea of overlapping spectra was abandoned, it being clear that every hue of colour had its own peculiar generating wave. Hence Brewster's elegant and simple explanation of colour-blindness fell to the ground.

Some years afterwards came out what is called the "Young-Helmholtz" theory, which assumes that the normal visual organs are capable of being impressed with three colour sensations, corresponding to red, green, and violet, and that all colour-perception is caused by the combined action of these in varying proportions. It is then assumed that in colour-blind people one of these sensations is wanting, leaving only the other two in action, and thus causing dichromic vision. The most common defect is supposed to be blindness to red, and on this hypothesis the colour-blind ought to see only violet and green. At the same time the supporters of this theory fancy they can detect some cases where the green is wanting, leaving only red and violet, and others where the violet is wanting, leaving visible only the red and the green.

This theory is in great favour, owing to the eminence of its authors and the support of many distinguished physicists; and it is adopted implicitly by Dr. Jeffries. But objections have been raised to it on several grounds, one of the most forcible being that it does not accord with the experience of the colour-blind. If there is any one fact more unequivocally deducible from their evidence than another, it is that the less refrangible colour they perceive corresponds to yellow, and not to green. In my own case, which I believe is a typical one, my long-wave colour is most vivid and positive, and it is an absolute certainty that its maximum splendour is excited by the buttercup, or by the pigment chrome-yellow, or by the sodium line; whereas objects that I hear called green give me no definite impressions at all; sometimes they assume a debased, dirty, or washed-out buttercup colour; sometimes they look black or grey; and sometimes they even give my opposite sensation, blue. How, therefore, it can be argued that my most brilliant buttercup sensation is excited by green objects rather than by yellow ones, is to me unintelligible.

A theory has lately been started by a Belgian *savant*, that the colour-blind defect is caused by an undue sensitiveness to green, which destroys the proper effect of other colours; to illustrate which he says that the normal eye, by looking through a certain green solution, will become colour-blind. But he carries his theory to the further length of asserting that if a colour-blind person looks through a certain red solution, he will be restored to normal vision, a conclusion which is so improbable that we may dismiss the theory from consideration, particularly as it has found no supporters.

There is, however, another hypothesis lately offered, which has a very different aspect. It was laid before the Academy of Sciences of Vienna a few years ago by Herr Ewald Hering, Professor of Physiology at Prague. Its scope is considerably wider than has to do with our present purpose, as it embraces the whole physiological theory of the perception of light, and it would be out of the question to give a complete account of it here. It is, however, of such great importance, and has been so favourably received by some of the highest authorities, that it may be worth while to devote a future article in NATURE to its description. Meantime it may be briefly stated that the author assumes, not three fundamental colour-sensations, as in the Young-Helmholtz theory, but (excluding black and white, for which he provides separately) *four*, namely, blue, yellow, red, and green.[1]

These, however, result from only two sources of sensation, each of which is capable of a double, or reversible, mode of excitement (in a manner somewhat analogous to positive and negative in electricity, or plus and minus in algebra), producing the sensation of two colours complementary to each other. Thus, one of the sources of sen-

[1] In the description of my own case, published in the *Philosophical Transactions* for 1859, I ventured to express the view that the assumption of these four colours as fundamental, was necessary in order to explain satisfactorily the phenomena of colour-blindness.

sation corresponds to blue and yellow, the blue rays exciting it in one direction and the yellow rays in the other. The other source corresponds to red and green, and is excited in like manner. It will at once be seen with what admirable simplicity this will explain colour-blindness, avoiding the violence done to the evidence by the Young-Helmholtz doctrine. Normal-eyed persons possess both sources of sensation; colour-blind persons possess only one. The usual case is when the red-green source is absent, the patient seeing only blue and yellow; but the other defect is possible, giving blindness to blue and yellow, and vision only of red and green; and Dr. Stilling, who strongly espouses the theory, states that rare examples of this have been found. If both sources of sensation are absent, the patient sees only light and shade, and this case also is said to have been practically known.

It is a pity Dr. Jeffries has omitted to mention this theory, which, if it should be substantiated by further inquiry,[1] bids fair to be a most valuable contribution to our knowledge. In the meantime the phenomena of colour-blindness, from the important bearing they have on the nature of colour-perception generally, require much further careful investigation.

WILLIAM POLE

OUR BOOK SHELF

Elementary Lessons on Sound. By Dr. W. H. Stone, Lecturer on Physics at St. Thomas's Hospital. (London: Macmillan and Co., 1879.)

SINCE the publication, some five and twenty years ago, of Helmholtz's great work on musical acoustics, the study of the nature of sound has become popular. The ordinary phenomena of hearing must interest every one; but it is to the thoughtful student of music that the subject presents its chief attractions. We cannot imagine any intelligent musician who will not be desirous to know something of the foundation of the wonderful fabric he has to deal with, and to learn how the principles of science bear on the practice of the art.

It is well, therefore, that Messrs. Macmillan have included among their School Class Books one which gives, in a very small compass, a large amount of information as to the laws and phenomena of sound. The author has not only extracted the essence of what is contained in bulky and expensive treatises, sometimes in foreign languages, but he has also given much additional information from memoirs and transactions of scientific societies out of the reach of the ordinary public.

The application of acoustics to musical instruments is a useful addition, the subject being one which the author has made specially his own. He has also stated some of the simplest facts of the connection between acoustical phenomena and the structure of music; but this is too wide a subject, and involves far too complicated considerations to be fully dealt with in an elementary work of this kind.

We notice a few trifling errors, as, for example, on page 3, the monochord can hardly be said to be "named after" Pythagoras; and Tartini's *terzo suono* was intended by him rather as a guide to correct double-stopping than "tuning." On page 11, line 7, the expression "first partial" is probably meant to be "first overtone." On page 76 a pretty contrivance, by Mr. Francis Galton, is ascribed to Capt. Douglas Galton. These things are, however, of little consequence.

[1] It may be mentioned that one of the main points in the theory has lately received unexpected and powerful support from the brilliant discoveries of Bell and Kühne in regard to the physiology of the retina.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Local Colour-Variation in Lizards

THE interest which some notes by Messrs. Wallace and Giglioli (published in NATURE) have called forth with regard to the local variation of colour in reptiles causes me to publish these few lines.

Since the year 1874 I have been carefully studying this subject, and therefore wish to remove the generally prevailing opinion that no endeavours have yet been made to explain it. I have not thought it necessary to write this before, thinking that my works touching this subject were known to naturalists, or would have become known through the mention Mr. Carpenter makes of them. Such, however, is not the case. Neither English nor Italian zoologists have taken any notice of the newer German publications concerning the local variation of colour in lizards. They content themselves with merely mentioning many new and truly interesting instances of this variation, but leave unnoticed all attempts made to obtain an explanation of the same.

The first effort to explain this appearance was made by Mr. Eimer in 1872, at the time that the beautiful black and blue lizard was discovered on the Faraglioni rocks, near Capri. Prof. Eimer tries to explain this change of colour in the *Lacerta muralis* (which is green both on the Continent and the Island of Capri) by attributing it to an adaptation to the colour of the Faraglioni rocks. However, as those rocks are not of a bluish-black, but rather a yellowish-red colour, intermixed with a little gray, and as, moreover, the lizards there have no enemies against which they require protection, and therefore no adaptation is necessary, I considered Prof. Eimer's explanation a failure, and at the same time I tried to confirm by fresh facts my hypothesis made in 1874 ("Ueber die Entstehung der Farben bei den Eidechsen," Jena, 1874). This hypothesis, which, it is true, has till now met with little approval, is as follows:—The skin of the lizard has two layers of pigment. The black pigment, which lies lowest, gets the power, under the concentrated influence of the sun, to leave its motionless state, and is made to rise by the contraction which the nerves exercise on the cells containing it, and by forcing itself more or less upwards through the elements of the pale layer of pigment, gives us the impression of different colours. That change of colour which we are able to observe in chameleons in a short space of time, under the condition of a frequent change of light, takes place with lizards only in the course of ages, embodying itself in manifold degrees of development, and provided the animal does not change the locality, remains as a distinguishing characteristic of the form. If, however, the lizard changes its locality, if it is isolated on a rock or islet which has separated itself from the mainland, and is entirely and constantly exposed to the rays of the sun, as must naturally be the case on rocks which, like the Faraglioni or the Island of Ayre, are void of all vegetation, in that case, I say, the black layer of pigment is set in motion, and by constant successive risings to the surface at last gains a definite superposition over the yellow pigment, as has been the case with the black Faraglioni and Lilfordi lizards.

This phylogenetic development of colours can be traced (as I have already mentioned in the year 1874) by the individual development of colour in the lizard, but necessarily only under the constant strong influence of the sun on young individuals. Dr. Braun, in his work on the *Lacerta lilfordi*, informs us that the young lizard of the Island of Ayre has exactly the same colour as its typical form on the larger Balearic islands, and only turns black in the course of its growth.

Though we can only observe the turning black of these lizards in the individual growth of the animal, we can obtain a returning of the full-grown animals to their original paler colours by artificial means, that is, by preventing the rays of the sun from falling on them perpendicularly. By these means I completely discoloured numbers of the Faraglioni lizards and the brown ones from the island of Ponza. The former turned bluish-green, the latter brownish-green.

Before I pass on to an enumeration of the above-named trans-

formed lizards, I shall just mention a third endeavour which has been made to explain the black colour of the lizards inhabiting small islets.

In his interesting book, "Beiträge zur Descendenz-Theorie," Leipzig, 1876, Seidlitz has tried to introduce the belief that the black colour serves as an armour or protection to the animal against the burning rays of the sun. Thereupon I sought to prove that reptiles inhabiting the desert would need such a protection more than the others, yet they are not black.

As some might perhaps draw, from what I have said, the conclusion that, according to my hypothesis the reptiles of the desert should be also black, I must remark that the scorching rays of the sun in the desert effect so strong an elevation in the temperature of the soil, that it brings forth a relaxation in the animal, and slackens the energetic movement of the pigment, consequently the extreme heat counteracts the effect which the light produces, whilst on the islets of the Mediterranean the heat is alleviated by the sea breezes and by a certain degree of dampness. As we already know, all our European species of lizards carefully avoid the desert.

The dark-coloured lizards at present known, which inhabit small islands, are the following ones:—

1. *Lacerta muralis, var. archipelagica*, De Bedriaga: "Die Faraglioni-Eidechse." (Heidelberg, 1876; pp. 19.) *L. muralis, var.* B. Erhard: "Fauna der Cykladen," (Leipzig, 1858; pp. 80.) *L. muralis, var. C.*, Schreiber: "Herpetologia europæa." (Braunschweig, 1875; pp. 408.) *L. muralis, var. archipelagica*, v. Bedriaga: "Herpetologische Studien," im *Archiv für Naturgeschichte*, 1878.

Back and extremities black, covered with rows of green spots. Belly and tail black. Inhabits the Cyclades.

2. *Lac. muralis var. melisellensis*, Braun: *Lacerta lilfordi* and *L. muralis*; "Arbeiten aus dem zoolog. zootom. Institut in Würzburg, 1877."

Back brown, ornamented with six light longitudinal stripes. Belly dark blue, chin rather lighter. Length 130 mm. Inhabits the islet Melisello near the island of Lissa, in the Adriatic Sea.

3. *L. muralis, var. filflaensis*, De Bedriaga: "Die Faraglioni Eidechse." (Heidelberg, 1876.) Braun, *l.c.* v. Bedriaga: "Herpetologische Studien," in *Archiv f. Naturg.*, 1879. Günther: "Description of a new European Species of Zootoca," *Annals and Magazine of Natural History*, 1874.

Back black covered with small green specks, the under parts are deep blue. Length 212 mm. Inhabits Filfla, near Malta.

4. *L. muralis, var. faraglioniensis*, De Bedriaga: "Ueber die Entstehung der Farben bei den Eidechsen." (Jena, 1874.) *L. muralis var. cærulæa*, Eimer: "Zoologische Studien auf Capri." (Leipzig, 1874.) Braun, *l.c.*

Back black, the sides blue spotted with black; the belly a brilliant blue. Length 220 mm. Inhabits the Faraglioni Rock, near Capri.

5. *L. muralis, var. Latastei*, De Bedriaga: "Herpetologische Studien," in *Archiv f. Naturg.*, 1879, pp. 264.

Back and sides brown, or dark brown covered with black spots, sometimes with bluish green spots on the sides. Above the root of the forelegs a bluish spot. Length 205 mm. Inhabits Ponza near Gaeta.

6. *L. muralis, var. Lilfordi*, Günther: "Description of a New European Species of Zootoca," *l.c.* Braun, *l.c.*

Upper parts of a deep glossy black, lower parts of a beautiful sapphire blue. Length 175 mm. Inhabits the Island of Ayre, near Minorca.

7. *L. muralis, var. Gigliolii*, De Bedriaga: "Herpetologische Studien," 1879, *l.c.*

Forepart of the back covered with alternately green and blue stripes. The hind part of the back is dark blue. The sides are light brown with green and blue spots. The belly brick-red with (sometimes without) small blue stripes. Colouring varies. Length 175 mm. Inhabits Isla del Dragoneras near Majorca.

8. *L. muralis, var. Rasquineti*, De Bedriaga: "Herpetologische Studien," 1878, *l.c.*

Back olive brown with a black pattern. Blue eye-spots ornament the sides. Belly brick-red. The first longitudinal rows of the ventral scales are blue. Length 185 mm. Inhabits the islet La Deva near Arnao (Spain). J. VON BEDRIAGA

Heidelberg, August 28

Insect Swarms

THIS year being remarkable for "insect swarms," it is important that all possible information about them should be gained, so as to satisfactorily account for these phenomena. As to *Vanessa cardui*, which has been abundant throughout the spring and summer, it is possible that some of those specimens which occurred in the spring were the result of a migration from the Continent, but there is no doubt that the specimens which are now seen are nearly, *if not all*, bred in this country from ova deposited by the spring specimens, quite sufficient time having elapsed for the metamorphosis. With regard to *Plusia gamma*, I am of opinion that all the specimens seen, and they have been in profusion here from about August 10 till the present time, have been bred *in this country*. My reason for so believing is that the larvæ were most abundant in the spring, doing damage in gardens to a great extent. Some of these larvæ I fed up, the perfect insects emerging at the time *P. gamma* first appeared in abundance. My experience of the swarms of *P. gamma* is that they moved in no particular direction, merely passing in numbers from flower to flower, flowers being scarce this year, any apparent migration being simply a search for more flowers. Instead of putting the cause of these swarms down to "migration," endeavours should be made to discover the causes of the extraordinary periodical fecundity. It is quite probable, too, that next year, *P. gamma* and *V. cardui* will be scarce, as is frequently the case with *Colias edusa* and *hyale* after a year of abundance. J. H. A. JENNER

Lewes, September 13

Earthquakes

I HAVE observed, in several recent numbers of NATURE, various notices of earthquakes, so frequent as to suggest the idea to me (perhaps incorrect) that for several months past they have been more numerous than usual. Since my arrival in West Java I have experienced several severe shocks. On March 28, between 7 and 8 P.M., I was startled by a peculiar shivering as I sat in my chair. At first I imagined I was seized with a terrible feverless ague, but I was soon undeceived by the increased bumping and the clashing of my bottles, &c., and the vehement beseeching of *Tuhan* Allah, and the loud exclamations of the natives of, "We are here!" "We are all here!" I learned in a few days that several villages lying at the base of the peccant volcano, Gedè, had suffered; in particular the town of Ijandjoer, in which numerous houses were destroyed, many bridges broken down, the telegraph apparatus entirely thrown out of gear, and six or seven persons killed. The ground also opened and emitted volumes of smoke, while the Gedè itself burst out with extra vigour, throwing out, in addition to the usual white steamy vapour, large quantities of smoke and ashes, fortunately to no great distance. Throughout the 28th and 29th there was a succession of shocks. On June 3 I experienced a second earthquake, undulatory but not very severe; and again on the 5th, undulatory, of considerable duration, and severe enough to thoroughly shake the whole house and throw down unfixed objects. These have done no damage to life, as far as I have heard, and, beyond some houses being cracked in Batavia, little to property. Since the beginning of March there have been numerous shocks, but none so violent as those of March 28 and June 5. Immediately preceding the shock of June 5 there was a sudden and heavy fall of rain, the drops being very large. The direction of the wave was from east to west. HENRY O. FORBES

Kosala, Bantam, July

Leaping Power of Mantis[1]

I CAN state from my own observations of several different species, both in Ceylon, South Africa, and Fiji, that the power is possessed by many, chiefly in the larval stage, and that the distances they can spring from branch to branch are very considerable for the size of the insect. E. L. LAYARD

British Consulate, Noumea

[1] NATURE, vol. xx. p. 595.

OUR ASTRONOMICAL COLUMN

THE OUTER SATELLITE OF MARS.—The following positions of *Deimos*, the exterior satellite of Mars, are deduced from the data published in Prof. Asaph Hall's memoir, in which he determines the elements of the satellite-orbits:—

At Greenwich Midnight

	Pos.	Dist.		Pos.	Dist.
	°	″		°	″
Oct. 10	241·3	50·1	Oct. 21	44·0	46·8
11	28·4	23·6	22	60·8	55·7
12	55·1	61·7	23	200·6	22·4
13	98·7	15·5	24	234·0	65·7
14	229·3	56·8	25	272·4	20·6
15	245·9	42·0	26	47·1	58·0
16	39·0	36·7	27	64·9	48·6
17	57·6	60·4	28	213·4	35·0
18	161·8	12·5	29	236·6	64·7
19	231·7	63·0	30	317·7	14·4
20	254·1	31·6	31	49·7	64·2

The apparent diameter of Mars, assuming the diameter at the mean distance 9″·415, will be 17″·8 on October 10 and 19″·5 on October 31. The value adopted depends chiefly upon the double-image measures, and is smaller than that introduced in Leverrier's Tables of Mars, which was derived from observations with meridian instruments. The period of revolution of *Deimos* is 30h. 17m. 54s., and the mean distance from the centre of Mars 14,500 miles, so that the average orbital velocity is 50 miles per minute. The excentricity appearing to be very small, Prof. Hall assumes a circular orbit for prediction in 1879.

THE FIRST COMET OF 1699.—This comet was observed at Paris by Cassini and Maraldi from February 20 to March 2, and at Pekin by the Jesuit missionary, De Fontenay, from February 17 to February 26. The single orbit which figures in our catalogues was calculated by Lacaille; the following elements by Mr. Hind depending upon the observations of February 19, 24, and March 2, are very similar to Lacaille's, the only noticeable difference being an increase of rather more than 1° in the inclination:—

Perihelion passage, 1699, January 13·3998 G.M.T.

Longitude of perihelion	212 8·8
„ „ ascending node	321 41·5
Inclination	70 36·6
Log. perihelion distance	9·87426

Motion—retrograde.

The re-examination to a certain extent of the cometary orbits resting upon a single calculation appears by no means a futile work, as was shown by the circumstance pointed out in this column some time since, that Halley had inadvertently given the longitude of the *descending* node of the comet of 1698, in his "Synopsis of Cometary Astronomy," in place of that of the *ascending* node, and the mistake has been continued in all our catalogues.

NOTES

THE latest conflagration at Irkutsk has destroyed all the libraries of the town—the Public Library, the private one of M. Vaghine (which contained the unpublished MSS. of Gedenstrom), and that of the Siberian branch of the Russian Geographical Society, which latter contained a great variety of works about Siberia, some of them being very rare, a great number of works and MSS. on Buddhism, numerous collections of publications of foreign scientific societies (European, Asiatic, and American) who exchanged their publications with the Siberian branch, and a large assortment of works on physical sciences and natural history. The destruction of this library will be a very great loss to science altogether, if a new one be not immediately created. It would be difficult for a man of science inhabiting a great city or even the smallest town in Western Europe to understand the important services which this library—the only one in Central Asia—has rendered in the development of scientific knowledge and in giving a scientific character to the geographical exploration of Siberia. Many scientific men when staying in Irkutsk have largely made use of the library (we may name among them the well-known president of the Berlin Geographical Society, Prof. Bastian, and quote his interesting notice on Irkutsk), and the writer of these lines can testify, from his own experience, how immense were the services rendered by this library to him and to his young friends when they began their studies for scientific geographical explorations of Siberia at Irkutsk, *i.e.*, at a distance of some thousand miles from all intellectual centres. We think that all those who have the further development of scientific exploration at heart, should do their utmost to assist in creating a new and good library in that centre for the exploration of Siberia.

ON August 20 last, the centenary of the birth of Berzelius was celebrated in a fitting manner at Stockholm. All the principal newspapers commented on the event in leading articles, and reminded their readers in enthusiastic terms that through Linnæus and Berzelius Sweden obtained citizen-rights in the world of science. At Väfversunda in the province of Småland, the birth-place of Berzelius, a monument to the great chemist was unveiled on the same day, in the presence of a large concourse of country people.

THE steamship *Faraday*, which has successfully laid the new transatlantic electric cable from Scilly to Newfoundland, returns to Woolwich to take on board the shore end and the cable to be laid from Newfoundland to America. The Siemens electric works at Charlton are just now busy completing the preparation of these parts, which will be ready by the end of this month, when the *Faraday* will be moored in the Thames to receive them.

THE steamer *Dacia* left Greenwich a few days ago in order to lay the second electric cable which is to connect Marseilles and Algiers. When this communication has been established the tariff of telegraphic messages between France and Algeria will be diminished by half, being reduced to 1*d*. a word instead of 2*d*. as now. It is supposed that the augmentation of traffic with the colony will result in an increased income to the Government.

ON September 1 snow fell in the village of Neustadt (Holstein).

A TERRIBLE whirlwind is reported from the village of Hopsten, near Münster (Westphalia). It occurred on August 26, at seven P.M. The largest oaks were uprooted and broken down; many houses were partially destroyed, and *débris* of all kinds marked the path of the atmospheric disturbance, which proceeded in an easterly direction. Strange to say, the most complete calm reigned everywhere around at the time.

PHYLLOXERA has now made its deplorable entry into Italian vineyards. The destructive insect has appeared in the province of Como. The local authorities are making every effort to combat the plague.

IT was proved some time ago by M. de Heen that, for metals belonging to the same natural group, the product of the coefficient of expansion by the absolute temperature of fusion is a constant quantity. In another memoir just presented to the Belgian Academy, M. de Heen inquires how the coefficient of expansion of water varies with the nature and quantity of substances dissolved in it. He proves that there is also a remarkable relation between the coefficient of expansion of organic liquids belonging to the same homologous series and their boiling point; the product of the one by the other is a constant quantity. In connection with this, M. Spring points out that M. Pictet, guided simply by ideas introduced into science by thermodynamics, has come to the same conclusions as M. de Heen. M. Pictet shows (1) that temperature is represented by the length of calorific oscillations of the molecules of a substance; (2) that the temperatures of fusion of solids correspond to equal lengths of oscillations; and (3) that consequently, the product of the lengths of oscillation by the temperatures of

fusion must be a constant number for all solids. As the lengths of oscillation of the molecules of a body are measured by the coefficient of expansion, we see that the result is the same as that reached some time since by M. de Heen, and which is now extended to liquids.

IN a series of experiments recently described to the Vienna Academy, Prof. von Waltenhofen has sought to deduce from a direct measurement of the work done in induction of an electric current in a closed circuit of given resistance, the mechanical equivalent of heat. For induction, a magneto-electric machine was used, whose electromotive force was ascertained to be proportional to the number of revolutions. A dynamometric handle of the newest construction was attached, and it was furnished with an arrangement for receiving the work-diagrams. The induced currents were measured by means of a tangent galvanometer. The results were found to be in satisfactory agreement with Joule's equivalent.

AN interesting communication relating to the photography of spectra has recently been made to the Berlin Academy of Sciences by Herr H. W. Vogel. It is not very difficult to photograph the spectra of incandescent gases if the source of light is an induction spark which is produced by a current with an inserted Leyden jar. The photography of the much fainter spectra obtained by the simple induction-spark presents far more considerable difficulties, and these are the very ones which Herr Vogel has now completely mastered by the employment of so-called gelatine-dry-plates. These plates are remarkable for their extreme sensitiveness, which Herr Vogel has estimated to be at least fifteen times that of the ordinary wet plates. They keep good for years, it seems, and are already obtainable in the trade. By using them Herr Vogel succeeded in fixing the spectra of the little oxygen tubes prepared and studied by Herr Paalzow, thus rendering lines visible in the more refrangible part of the spectrum which cannot be observed by direct vision. The two gentlemen are now engaged in studying these spectra more minutely in company, and will doubtless soon publish the results of their researches.

A VIOLENT shock of earthquake, lasting forty seconds, is reported from the island of St. Thomas (West Indies). It occurred on July 30 at 11.35 A.M.

THE *Temps* publishes a letter from M. Francis Laur, a mining engineer, complaining that the French Parliamentary Commission appointed for preventing the effects of fire-damp, has given no sign of life, although a credit of 50,000 francs was assigned to it, and more than fifty inventors have sent in instruments or methods for examination.

M. FERRY, Minister of Public Instruction, has published an official circular for the better organisation of the bursaries granted after examination to students taking their degrees in the several French universities. These bursaries are of quite recent foundation and present a strong similarity to the sizarships or scholarships in the English universities.

AMONGST European countries there are two where science has been dreadfully neglected up to the present time. For one of these two, viz., Turkey, we are afraid there is not much hope of reformation, at least in its present condition. It is satisfactory, however, that the other one, viz., Spain, seems at last to be awaking from its lethargy with regard to science. Some time ago we had occasion to refer to a commendable *Cronica cientifica*, published annually in two volumes, by Dr. Emilio Huelin, of Madrid. Another publication which appears monthly, the *Revista contemporanea*, of which Dr. Francisco de Asis Pacheco is the editor, has just come under our notice. The last number of this serial contains an excellent article on the sciences in 1879, by Ricardo Becerro y Bengoa, giving a most elaborate account of the work done recently in all branches of science. The publishers are Señores Perojo Hermanos, of Madrid, who also publish *La Naturaleza*, an illustrated science review, in two volumes annually.

THE project of building a canal from Amsterdam to the Rhine (in continuation of the new canal between that city and the German Ocean) has lately been again brought before the Dutch Government. Our readers are aware that the project is not new, and it is easy to see the great advantages its execution would bring to the commerce of Holland generally and of Amsterdam in particular.

AT a recent meeting of the United States Anthropological Society, Mr. F. H. Cushing, who has made an original and experimental study of aboriginal processes in the manufacture of pottery, stone axes, and flint arrow-heads, using only the tools which were within the reach of the aboriginal manufacturers, gave an interesting description of the manner in which flint implements, especially arrow- and spear-heads, were made by the prehistoric inhabitants of this country and Europe, previous to the discovery or introduction of iron. It is the popular impression that flint arrow-heads were all chipped into shape by striking off fragments with a rude stone hammer, and this was the method first tried by Mr. Cushing. He found, however, that it was impossible to imitate in this way any of the finer and more delicate specimens of Indian arrows, and that three out of four even of the coarser forms were broken in the process of manufacture. It was evident, therefore, that the Indians had other and more delicate processes. After many unsuccessful experiments, he accidentally discovered that small fragments could be broken off from a piece of flint with much greater certainty and precision, by pressure with a pointed rod of bone or horn, than by blows with a hammer-stone. The sharp edge of the flint would cut slightly into the bone, and when the latter was twisted suddenly upward a flake would fly off from the point where the pressure was applied in a direction which could be foreseen and controlled. To this process Mr. Cushing gives the name of flaking, to distinguish it from chipping produced by percussion. And its discovery, he considers, removes most of the difficulties which previous experimenters had met with in trying to work flint without the use of iron. Spear- and arrow-heads could in this way be flaked even into the most delicate and apparently fragile shapes with a certainty attainable in no other way, and with a greatly-lessened probability of breakage. Mr. Cushing then described, with the aid of blackboard illustrations, all the steps in the manufacture of an arrow, beginning with the striking off of a suitable flake from the mass of material selected, trimming it roughly with a pebble into a leaf-shape with a bevelled edge, scaling off surface flakes by repeated blows with a hammer-stone upon this edge at right angles to its plane, and finally finishing, pointing, and notching the arrow-head with the bone flaking-instrument previously referred to.

THE Russian Foreign Ministry has just published a very good Russian and Chinese dictionary, by the first translator of the Russian mission at Pekin, M. P. S. Popoff. The work is printed by a new kind of autography devised by M. Alisoff.

M. FERRY has published an order for the appointment of librarians in the establishments of the University. No one is to be appointed except after two years' trial and passing successfully a professional examination. This is to consist of a French dissertation on a given subject of bibliography, and the classification of fifteen works treating of different matters, and belonging to several periods of the history of the art of printing.

THE Musée Scolaire, which had been removed by the Minister of Public Instruction to one of the halls of the Palais Bourbon, is to resume its former situation. The hall in which it had been located is wanted by the questors for the installation of the

Chamber of Deputies which, as is known, is to be transferred to Paris in November next, there to hold its sessions, so long as the Parisians do not oppose it by a revolution.

AT the Stuttgart meeting of the International Geodetic Association in 1878, M. Faye suggested a method of avoiding the flexure of a pendulum-support, viz., that two similar pendulums should be oscillated on the same support with equal amplitudes and opposite phases. The idea was thrown out on the spur of the moment, and was not received with very warm approval. By a mathematical discussion of the method in a paper to the U.S. National Academy (*Silli. Journ.*, August), Mr. Peirce endeavours to prove that the suggestion is as sound as it is brilliant, and offers some peculiar advantages over the existing method of swinging pendulums.

AT the International Alpine Congress at Geneva Prof. A. Favre pointed out the necessity of making measurements of glaciers. The retrocession of glaciers has been general during the last twenty-five years. Prof. Favre is of opinion that this retrocession period will come to an end after some time, and will be succeeded by a period of advance. The German and Austrian Alpine Club, at its last general meeting at Saalfelden, resolved to make the measurements in question on all the glaciers of the Austrian Alps.

THE third volume of Dr. Karl Russ's work on foreign domestic birds, containing the natural history and cultivation of parrots, has just been published by C. Rümpler, of Hanover.

A NEW oil plant (*Lallemantia iberica*) has been acclimatised on the fields of the Agronomical School at Cherson (South Russia). It belongs to the *Labiatæ* family, and is very similar to *Dracocephalum*. The herb attains a height of $1\frac{1}{2}$ to $2\frac{1}{2}$ feet and bears some 2,500 seed-grains, which give a most pure oil, applicable even for culinary purposes. The seeds of this originally Persian plant were first sent to Cherson by Prof. Haberlandt, of Vienna.

WE learn that M. Europeus still continues his most interesting researches into the prehistoric Finnish population of North-Western Russia. During last summer he explored the *koorganes* (mounds) of the province of Olonets, and on the banks of the Oyak river he discovered many bronze implements similar to those brought in by Ujfalvi from the banks of the Irtysh in Siberia. The remains of the Korels in the district of Olonets throw a new light on the geographical distribution of this people. M. Europeus has arrived at the conclusion that during the first centuries of the Christian era the whole of North-Eastern Europe and the north of the Scandinavian peninsula were peopled by tribes of Finnish-Hungarian and Finnish-Ugrian origin, who formed an extensive and strong state. Only the shores of Lake Onega had a purely Finnish population. All skulls in the *koorganes* of the region formerly occupied by Finns, are of the brachycephalic form.

COUNT T. SALVADORI'S great work on Papuan ornithology, "Ornitologia della Papuasia e delle Moluche," is in a forward state, and it is hoped that the first part (containing the Accipitres, Psittaci, and Picariæ) will be ready about the end of the year. The second part will be devoted to the Passeres, and the third to the remaining orders. The total number of species contained in the work will be about 900, the area embraced being the whole of the Austro-Malayan sub-region, with the exception of Celebes and the Timor group of islands.

A RAILWAY is now being built between Tiflis and Baku, and is expected to be completed in about four years.

WE have received the fourth volume of the *Bulletin* of the Société Ouralienne, *i.e.*, the Natural History Society of Ekaterinburg, Russia. The volume contains some interesting data on the flora of the Ural Mountains, by M. G. O. Clerc; also some notes on rain-gauges and on the quantity of rain and snow which falls at Dolmatoff (average computed from observations extending over fourteen years), by the same. Another valuable contribution is by M. N. P. Boulytcheff, and treats of the flora and the fauna of the Irbit District. All these papers are given in the Russian original and in a French translation. An original German paper is by Dr. J. Hann, on the daily course of magnetic declination in Russia, but only the Russian translation is printed.

THE Congress of German Horticulturists which took place at Cassel this year will meet at Bremen next year.

AT South Arcot (Presidency of Madras) experiments have been recently made with the fibres of aloes, which grow there in abundance, with a view of preparing paper from this material. A product was obtained which considerably surpassed the ordinary Indian paper in quality, and it is now intended to make the experiments on a larger scale in this country.

THE St. Gothard tunnel, which will measure 14,920 metres when completed, has now reached a length of 13,229 metres. It is hoped that by the beginning of December next the gigantic work will be finished.

THE additions to the Zoological Society's Gardens during the past week include a Guinea Baboon (*Cynocephalus sphinx*) from West Africa, presented by Mr. F. Naylor; a White-fronted Capuchin (*Cebus albifrons*) from South America, presented by Major H. L. Gleig; a Black-faced Spider Monkey (*Ateles ater*), two Black Tortoises (*Testudo carbonaria*) from South America, two Martinican Doves (*Zenaida martini cana*) from the West Indies, presented by Capt. Henry King; a Plantain Squirrel (*Sciurus plantani*) from Java, presented by Miss Lizzie Casey; an Indian Jackal (*Canis aureus*) from India, presented by Mr. Thos. Thursfield, M.R.C.V.S.; a Demeraran Cock of the Rock (*Rupicola crocea*) from Demerara, presented by Mr. R. S. Fraser; a King Parrakeet (*Aprosmictus scapulatus*) from New South Wales, presented by Mr. Geo. Wood; a Red and Blue Macaw (*Ara macao*), a Red and Yellow Macaw (*Ara chloroptera*) from South America, deposited; an African Brush-tailed Porcupine (*Atherura africana*) from West Africa, a Vulpine Squirrel (*Sciurus vulpina*, var. *capistrata*) from North America, purchased.

THE BRITISH ASSOCIATION

REPORTS

Report of the Committee for exploring Caves in Borneo. Drawn up by Dr. J. Evans, F.R.S.—The Committee report that with the grant of 50*l*. from the Association, a similar grant from the Royal Society, and a farther sum of about 200*l*. from private sources, they have been able to prosecute an examination of various caves in Borneo, under the superintendence of Mr. A. S. Everett, who has devoted himself to the task for a period of nearly nine months.

The final report upon his work has not yet been received, but it appears from his letters and from the specimens which have been transmitted to this country, that nothing of special interest either from an anthropological or a geological point of view has resulted from his explorations. The animal remains discovered have all been of recent species; the human bones are probably of no great antiquity, and none of the few objects of human manufacture which have been found can be regarded as of palæolithic age.

Pending the arrival of Mr. Everett's final report it appears needless to enter into details; but it may be mentioned that upwards of twenty caves appear to have been explored, in a more or less complete manner, and the principal objects found, after examination by some of the members of the Committee, have been forwarded to the British Museum. Although the examination of these caves has not, as was hoped, thrown any light upon the early history of man in that part of the world, it is still satisfactory that the examination should have been made

and the character of the cave-deposits ascertained by so competent an observer as Mr. Everett. The evidence obtained, though negative, is not without value, and those who are specially interested in cave-explorations, and who have so liberally assisted in the present instance, cannot be reproached with not having availed themselves of the opportunity afforded by Mr. Everett's presence, of obtaining farther information as to the contents of the Borneo Caves.

It may be added that though for the most part the objects secured were unimportant, there were among the cave-deposits a number of shells of land and freshwater mollusca, which have been examined by Col. Godwin-Austen, and have proved to belong to at least 25 genera and 40 species, some of which are apparently new. Mr. Everett has been requested to devote some attention to collecting a larger series of these shells, but owing to the difficulties of postal communication it is possible that the request may arrive too late.

The Committee propose to communicate Mr. Everett's final report, together with any observations which seem called for on the specimens which are still to arrive, to the Royal Society.

Underground Waters.—The fifth report was presented of the Committee appointed in 1874 to inquire into the circulation of underground waters, and the extent to which they may be made available for the water supply of towns and districts. The Committee state that, as the objects of the inquiry become more widely known, there is increasing inclination shown by engineers and contractors to impart information, which accrues from day to day, and that they consider it desirable to continue their labours until it becomes the duty of some Government department to undertake the charge. They desire to extend their inquiry beyond the Permian, Triassic, and Jurassic rocks to all permeable formations yielding supplies of potable waters. A large amount of valuable information has been collected in the Midlands and in other districts, of works in progress which will be reported on next year. The attention of the Reporter of the Committee (Mr. De Rance) has been specially directed to ascertaining the areas of pervious rocks, in each of the river basins of England and Wales, and of the areas of impermeable rocks overlying permeable formations, and forming "supra-pervious" areas, together occupying an area of more than 25,000 square miles, and capable of yielding an amount of water far in excess of the quantity required for manufacturing and potable purposes. The impermeable nature of the Severn river-basin is alluded to, and the consequent danger of abstracting a large volume of its waters for Liverpool water supply commented on.

Report of the Anthropometric Committee.—This Committee had been appointed for the purpose of continuing the collection of observations on the systematic examination of heights, weights, &c., of human beings in the British Empire and the publication of photographs of typical races of the empire. Considerable progress had been made during the past year, and returns, giving the birth-place, origin and sex, age, height and weight, colour of hair and eyes, girth of chest, strength of arm and eyesight, of pupils at Westminster and other schools, London policemen and letter sorters, workmen, rifle volunteers, soldiers and criminals, had been obtained. By this means the Committee were put in possession of nearly 12,000 original observations on the main question of weight and height in relation to age, in addition to 50,000 already collected. The Committee submitted a series of tables made up from the information contained in the returns. From these it was shown that the London letter sorters were the lowest in height, the average heights between the ages of 20 and 35 being 64 to 67·1 inches. The letter sorters were also at the bottom of the weight table, their average weights in lbs. being 122·5 to 139·9. The metropolitan police were at the head of both lists; height 69·2 to 71·5 in., and weight 162·5 to 182·7 lbs. Other tables were given, showing that the average height and weight varies with the social position and occupation of the people, and that to obtain the typical proportions of the British race it would be necessary to measure a proportionate number of individuals of each class. Taking the census of 1871, they would find that a model community would consist of 14·82 per cent. of the non-labouring class, 47·46 per cent. of the labouring class, and 37·72 per cent. of the artisan and operative classes. The nearest approach to such a representative population in a limited space would be found in some of the larger county towns, such as York, Derby, or Exeter. The tables demonstrated that the full stature is attained in the professional class at 21 years, and in the artisan class between 25 and 30 years. American statistics showed that a slight increase in height takes place up to the 35th year. The growth in weight does not cease with that of the stature, but continues slowly in both classes up to about the 30th year. The report concluded by referring to similar investigations which are being made in other countries, and the coincidence of the several inquiries led to the hope that information of great value might in due course be elicited.

SECTION A—MATHEMATICAL AND PHYSICAL

On Secular Changes in the Specific Inductive Capacity of Glass, by J. E. H. Gordon, B.A.—At Christmas, 1877, I made some determinations of the specific inductive capacity of optical glass by a method which has already been fully described both before this section and elsewhere.[1]

At the end of July, 1879, I commenced a repetition of the experiments, using the same slabs of glass, and was surprised to find a large increase in the specific inductive capacity in every case. In some cases the increase was as much as 20 per cent.

The following is a table of the results:—

Specific Inductive Capacity of Optical Glass

	Christmas, 1877	July and August, 1879
Double extra dense flint	3·164	3·838
Extra dense flint	3·053	3·621
Light flint	3·013	3·443
Hard crown	3·108	3·310

The arrangement of the apparatus, including the coil and rapid break, was precisely the same as in my earlier experiments. The electromotive force was as nearly as possible the same, and experiment has shown that moderate variations in it do not affect the results.

The differences observed might have been caused by any one of three things:—

1. By error in the 1879 experiments.
2. By error in the 1877 experiments.
3. By a change in the specific inductive capacity of the glass between Christmas 1877 and July 1879.

[The author, after showing reason for the rejection of (1) and (2) is led to the conclusion that in the course of a year and a half an actual change has taken place in the glasses, which is shown by a considerable real increase in their specific inductive capacities.] To complete our knowledge of this new phenomenon we require a series of monthly observations, extended over perhaps a period of several years. I shall hope to be able to give the results of another year's experiments at the next meeting of the Association.

These experiments have some importance as regards Prof. Clerk-Maxwell's electro-magnetic theory of light. In a recent lecture[2] I ventured to suggest "that it is quite possible that the relation between electric induction and light exists—namely, that they are disturbances of the same ether, but that there is some unknown disturbing cause affecting the electric induction."

Possibly a clue to the nature of this disturbing cause may be found in the fact, that the specific inductive capacities are affected by some of the changes which chemists tell us are constantly going on in glasses, but that these changes do not affect the refractive indices.

SECTION B—CHEMICAL SCIENCE

Mr. W. Chandler Roberts, F.R.S., Chemist of the Mint, read a paper *On some Experiments with the Induction Balance.*—He stated that the instrument, which we owe to Prof. Hughes, the discoverer of the microphone, appeared to be one of no ordinary importance, and although the experiments about to be described were far from complete, they possessed sufficient interest to warrant their being submitted to the Section. He then described and exhibited Prof. Hughes's instrument, showing the extreme delicacy by which changes in the induced current were indicated by the microphone and telephone.

The relative values of different metals, as indicated by the induction balance, do not accord with the values usually accepted as representing the relative conductivities of the respective metals, and this being the case, Mr. Roberts had ascertained what rela-

[1] *Report* Brit. Assoc., 1878; *Proc.* Roy. Soc., 191, 1878; *Phil. Trans.*, 1879; "Four Lectures on Electric Induction," delivered at the Royal Institution (Sampson Low and Co., 1879.)

[2] Royal Institution, February 6, 1879.

tion the indications given by alloys, when under the influence of the induced current, bear to their electric conductivities.

The experiments on a comprehensive series of alloys proved that, in the case of alloys of certain metals, the induced-current curves closely resembled those representing electric conductivity, but that in certain other cases the induced current revealed differences that had hitherto escaped observation. As an example, Mr. Roberts alluded to the curve of the copper-tin alloys, in which there is a sudden break between the points representing two alloys, which only vary by a single equivalent, or by 6·4 per cent. of copper. These two alloys are widely different in colour, fracture, density, and structure, and the induction-balance at once afforded evidence of a marked difference not shown in Matthiessen's curve of electric conductivity.

It is known that certain metals, when alloyed, undergo a molecular change, and that an allotropic condition may in some cases be induced by alloying a metal with a small quantity of another, facts which well deserve minute examination as bearing on the non-elementary character of certain metals, which is now receiving so much attention.

Mr. Roberts then referred to the question of applying the induction-balance to the assay of metals. In the case of gold-silver alloys the instrument will show the presence of less than two grains of gold in the pound of silver. On the other hand, the silver-copper alloys used for coinage are situated at the flat portion of the curve, so that it is impossible to detect even considerable differences in their composition, and these alloys which are very peculiar to their nature, appear to be greatly affected by annealing. More hopeful results were obtained with the gold-copper alloys, and Mr. Roberts demonstrated a difference of 1 per cent. in the standard of two gold disks, which, though far short of the existing method of assay in delicacy, appeared to afford grounds for the belief that very accurate results will ultimately be obtained.

Notes on Petroleum Spirit or Benzoline, by A. H. Allen.—The application of the commercial names "benzoline" and "benzine" to the more volatile portion of petroleum has led to great confusion between petroleum spirit and coal-tar naphtha, the most characteristic constituent of which is the hydrocarbon *benzene* or *benzol*. In this paper the author mentions several tests for distinguishing between the two bodies, the most important of which are the following:—

Petroleum Spirit, "*Benzoline or Benzine*," warmed with four measures of nitric acid of 1·45 sp. gravity the acid is coloured brown, but the spirit is little acted on, and forms an upper layer.

Coal-Tar Naphtha or "Benzol" is completely miscible with four measures of nitric acid of 1·45 sp. gravity, with great rise of temperature and production of dark brown colour.

These tests are capable of yielding quantitative results if the treatment with nitric acid be conducted in a small flask and an inverted condenser attached, to prevent loss of vapours. When action has nearly ceased, if the liquid be poured into a narrow graduated tube, the measure of the upper layer indicates with approximate accuracy the amount of petroleum spirit present. If the proportion of benzene is considerable, the nitrobenzene produced may not remain completely dissolved in the nitric acid, in which case it rises and forms a layer of a dark brown colour below the stratum of petroleum spirit. Nitrobenzene and petroleum spirit are readily miscible in the absence of nitric acid, but agitation with strong nitric acid dissolves out the nitrobenzene, a portion of which may rise and form an intermediate layer as above described.

By fractional distillation, the author found that the porportion of *heptane*, C_7H_{16}, present in commercial benzoline probably equalled, or even exceeded, that of all the other constituents.

On some Curious Concretion Balls derived from a Colliery Mineral Water, by Thomas Andrews, F.C.S.—The water on which these observations were made was collected from the "sump" of the Wortley Silkstone Colliery, a small pit situated near the "Bassett" or "outcrop" of the great Silkstone seam of coal, the samples being obtained during typical *dry* and *rainy* seasons. The water had percolated from the surface a distance of thirty-five yards, through strata, as indicated on the accompanying table.

The bottom layer in which the water lodged was the Silkstone seam of coal, here some five feet in thickness.

One noticeable feature of this water is that it always gives an acid reaction with blue litmus paper.

Several analyses of this water made at various times indicate that the chief mineral constituents of the water are, iron—calcium, magnesium, in the form of sulphates.

This water when heated quickly throws down a copious ochreous deposit. The deposit found in the engine boilers, after having used the water in them for steam purposes was of the composition given below.

The boiler residue from which this sample was taken consisted of an incrustation about *one inch* thick, which had adhered to the bottom of the boiler.

The incrustation was of a light reddish yellow colour in the bulk, it was very hard and tough, and not easily broken in pieces.

The iron work in connection with this colliery engine and boilers, in any way exposed to the action of either the acid water itself or *the steam generated from it*, becomes corroded and partially dissolved. The most effectual remedy against this corrosive action and deposit is that described in my letter to the *Chemical News*, June 15, 1877.

Some curious balls of mineral matter are occasionally found in the feed tank of the colliery boilers, which are supplied with this water. The water is pumped up from the engine pond into a cylindrical feed tank, and is there heated by the exhaust steam from the engine playing on its surface (not blowing through it). The water in this feed tank has an average temperature of 164° F.

It sometimes happens that during the short space of even two or three weeks, great numbers of these balls are formed, varying in size from about three and a half inches in diameter to five-eighths of an inch diameter, and in weight from about one and a half pound to a quarter of an ounce.

The author has many of these in his possession. They are perfectly hard and compact when taken from the tank, and are, no doubt, formed from the deposit thrown down when the mineral water is heated.

The action of steam playing on the surface of the water probably causes circular eddies, and when a nucleus has thus once been formed, it is easy to conceive of the gradual formation and consolidation of these balls.

The author suggests that the conditions of formation of natural nodules of iron ore, pyrolusite, &c., may be similar to those observed by him in the foregoing cases.

On the Detection of Milk Adulteration, by William H. Watson, F.C.S., &c.—From analyses of milk from various dairies, and by a comparison of the results obtained with circumstances existing as to the character and quantity of the food; nature of different cows; conditions and health of them at particular periods; and changes of the seasons of the year, the author concludes that cows' milk is subject to considerable variations in composition. He has found, in many instances, milk from well-fed healthy cows to contain as little as 10·5 per cent. of total solids, and from 8·5 to 9 per cent. of solids not fat. The results of other experimenters are compared, and it is then suggested that the present limits adopted by public analysts for genuine milk should be reconsidered.

SECTION C—GEOLOGY

On the Volcanic Products of the Deep Sea of the Central Pacific, with Reference to the "Challenger" Expedition, by the Abbé A. Renard and J. Murray.—The mineralogical and petrological researches on the sea-bottom of the Pacific area, extending from the Sandwich Islands to 30° S. lat., and having the Low Archipelago on its approximate centre, show that volcanic matter plays an important part there. It is present in the form of lapilli and of ashes spread in great abundance in the "red clay." These lapilli nearly all belong to the basaltic type, passing from the felspathic basalts to allied rocks, in which the vitreous base assumes greater and greater development, until it almost completely displaces the crystalline constituents of basalt. The fragments then become mere glassy rocks of the basic series, in which generally are still found crystals of peridote and numberless crystallites, which are sometimes grouped in opaque granules, or arranged regularly around the microliths of peridote. The forms of these volcanic fragments, which are often coated with manganese, their association with volcanic ash, and their lithological constitution, show them not to be derived from submarine flows of lava. They must rather be regarded as incoherent products, or lapilli, the accumulations of which in the Pacific form a series of submarine tuffs. One of the most remarkable facts elicited by the soundings in the Pacific is the large share

taken in these sedimentary deposits by palagonites, quite identical in lithological characters with those of Sicily, Iceland, and the Galapagos Islands. One may, in fact, call them glasses of the basic series, playing the most important part among the sediments of the Pacific, and consisting either of sideromelane or decomposed into a red resinoid substance. The small lapilli of two or three inches in diameter are cemented by zeolites, the crystalline forms of which are those of christianite. It is enough to indicate the presence of the easily alterable basic glasses, in order to show the source of the clayey matter with which they are associated, since it is known that wherever rocks of this type occur, there also decomposition into clay is observable.

Amongst the minerals present in the volcanic ash are rhombic tabular crystals of plagioclase, augite, magnetite, with a little sanidine or hornblende. It is also remarkable to notice that in these deep-sea deposits quartz grains are practically absent, in striking contrast to the coast-deposits. It is not, however, this fact which is most worthy of note, since it is not so unexpected as the formations of *zeolites* in the free state. The latter phenomenon takes place in the zone in question where minute fibrous radiated spherules are formed in the mud, possessing the crystallographic characters of christianite. Besides these zeolitic globules, there are other crystals of the same kind in the form of very minute prisms, occurring in such prodigious numbers that they make up about a third of the red clay. Crystallographically these microliths must be referred to those forming the zeolitic spherules. The authors regard them as belonging to one species. The formation of these zeolites and of the red clay in which they are developed, is easily understood if we bear in mind the lithological nature of the above-described basic tuffs and of their products of decomposition.

The Geological Age of the Rocks of West Cornwall, by J. H. Collins, F.G.S.—Mr. Collins endeavours to show that a large area of West Cornwall, hitherto mapped as Devonian, really consists of upper Silurian rocks; lower Silurian rocks underlie them, whilst a still older series occurs at several points on the coast—possibly the mica schists of the Lizard belong to this oldest series.

Geological Facts observed in Natal and the Border Countries, by Rev. G. Blencowe.—Mr. Blencowe describes the country near the border of Zululand. The rocks are sandstone, capped by trap, which often stands out in isolated hills rising 2,000 feet above the plain. Evidences of ancient volcanic action are noticed.

On "Culm" and "Kulm," by Prof. G. A. Lebour, M.A., F.G.S.—He suggests that the English word "culm" be retained as a local term for the culm measures of Devon and Somerset. Under the Germanised form of the name ("kulm") are now grouped a vast mass of carboniferous slaty beds which strike across Europe from Eastern Silesia to the westernmost point of Portugal; these beds represent, not the coal measures of England, but the carboniferous limestone and underlying beds.

On some Remarkable Pebbles in the Boulder Clay of Cheshire and Lancashire, by Dr. C. Ricketts.—The pebbles give evidence of having formed parts of moraines on land. As they occur at different horizons it is inferred that there must frequently have been an advance and retreat of glaciers, moraines being formed during the retreat of the glacier, which were carried forward into the sea when the glacier advanced.

Notice of the Occurrence of a Fish Allied to the Coccosteus in a Bed of Devonian Limestone near Chudleigh, by J. E. Lee, F.G.S. —This occurs (in the upper or middle Devonian) with clymenia, goniatites, and crinoidal remains, and therefore cannot here be a freshwater fish.

Evidence of the Existence of Palæolithic Man during the Glacial Period in East Anglia, by Sydney B. J. Skertchly, F.G.S., H.M. Geological Survey.—The object of this paper is chiefly to record the sections in which the author has discovered palæolithic implements beneath the chalky boulder clay in East Anglia.

The beds which yield the implements are a series of loams, clays, and sands, to which the author has given the name of Brandon Beds. They occur at the top of the middle glacial series of Messrs. S. V. Wood, jun., and F. W. Harmer, and underlie the chalky boulder clay or upper glacial of the above-named authors.

On Carboniferous Polyzoa and Palæocoryne, by G. R. Vine.—In this paper the author drew attention to the inadequate study that had been given to the carboniferous Polyzoa. During the last few years vast masses of shales, containing Polyzoa and other remains have been brought to light, but none that he was acquainted with excelled in richness the Hairmyres *débris*. Here the specimens were well preserved and the characters of the several species were almost perfect.

The author considered that it was too early yet to draw up a classification that would be satisfactory to all naturalists. Attempts had been made to do this, but many details had to be furnished that could only be furnished after close study. Besides the *Fenestella*, other genera were alluded to in the paper, such as *Cenopora*, *Rhabdomeson*, *Hyphasmapora*, *Glauconome*, and *Diastopora*; but these are being studied analytically, and further details of their structure will be brought forward in a future report.

Palæocoryne was next alluded to, and the author said that he had identified all the species and forms of Palæocoryne that had been figured by Dr. Duncan in his various papers; but the conclusion the author had arrived at was—that these so-called organisms were neither hydroid, as was supposed by Dr. Duncan, nor foraminiferal, as was suggested by Dr. Allman. All the forms were referable to species of *Fenestella* and *Polypora*. Although this opinion was given with some confidence the author was not prepared to say at present that the whole of Dr. Duncan's views were illusive. There can be no doubt but that the forms *P. scotica* were really infertile processes; but *P. radiata* had presented so many peculiar details to the author, that until he had satisfied himself as to the nature and purpose of this structure in the polyzoary of the Polyzoa, he was not prepared to substantiate that Dr. Duncan had given an erroneous judgment, although *P. radiata* may turn out to be after all a portion of *Fenestella* and not a parasite.

On the Replacement of Siliceous Skeletons by Carbonate of Lime, by W. J. Sollas, M.A., F.G.S., &c.—The author gave an account of certain calcareous fossil remains which exhibit, both in gross and minute structure, a close resemblance to certain existing siliceous sponges, and which differ widely from any known form of calcareous sponge. The natural inference appeared to be that the calcareous fossils were once siliceous sponges, the siliceous parts of which had undergone replacement by carbonate of lime. The alternative view that the fossils were originally calcareous, and that they represent an extinct group of Calcispongia, was discussed and shown to present far greater difficulties to the zoologist than the inferred mineral replacement offered to the chemist. Siliceous sponge spicules were stated to be remarkably soluble, yielding readily to the attacks of minute boring algæ, and undergoing solution in sea-water soon after the death of the sponge which possessed them.

The radiolaria of the carboniferous limestone were likewise regarded as having once possessed a siliceous composition, which they had since exchanged for a calcareous one.

On the Foundations of the Town Hall, Paisley, by M. Blair.—Dolerite underlies the boulder-clay there, and is probably the source of boulders of a similar rock which occur in the drift, and which have hitherto been considered as strangers to the neighbourhood.

On "Ostrakocanthus dilatatus" (gen. et sp. nov.), a Fossil Fish from the Coal-Measures South-east of Halifax, in Yorkshire, by J. W. Davis, F.G.S.—This is an ichthyodorulite nearly $1\frac{1}{2}$ inches long, and $\frac{3}{4}$ inch broad at the base. From the base the diameter diminishes rapidly, and at half an inch from the apex it is only ·15 of an inch. It remains of this size to the apex, and ends in a blunt point. The upper part is smooth, with hard ganoid covering. The lower part is longitudinally furrowed, increasing by bifurcation towards the basal end. At first sight it somewhat resembles the *Byssacanthus* of Agassiz, and also the spine of *Ostracion cornutus*, but the similarity disappears on closer examination. From the spine and its mode of attachment it is probably a representative of the Teleosteans during the coal period.

SECTION D—BIOLOGY

Department of Zoology and Botany

On the Capreolus or Spermatophore of some of the Indian Species of the Helicidæ, by Lt.-Col. H. H. Godwin-Austen, F.Z.S., &c.—The author points out the importance of the examination of the animal in many genera of the Helicidæ, and thus to obtain better characters for specific distinction than are often presented by the shell alone. The organ first discovered and described by Lister in 1694 is treated of, and the views of later naturalists al-

luded to. Many different forms of the spermatophore found in Helices from Eastern Asia, are shown and the position of the organ in the generative system of *Helicaria magnifica* from Burmah is described.

On Budding in the Syllidean Annelids, chiefly with Reference to a Branched Form from the "Challenger," by Dr. W. C. McIntosh, F.R.S.—Propagation by budding is a prevalent feature amongst the Cœlenterata, the organisms assuming in many cases a dendritic appearance, so that the name of sea-trees given to them by our fishermen is by no means inappropriate to their external contour. A similar condition is seen in many of the Polyzoa, and in the creeping stolons of *Clavelina* and *Perophora*. In the sub-kingdom Vermes, again, naturalists have been long familiar with a mode of propagation by division or fissiparous development. Thus O. F. Müller describes two kinds of budding in the fresh-water *Nais proboscidea*, and gives an account of the same process in *Nereis prolifera*. Amongst others, De Quatrefages and Frey and Leuckart in the same species; Milne-Edwards in *Myriandra*; Sars in *Filigrana*; O. Schmidt in *Nais microstoma* and *Filigrana*; Max Schultze, R. Leuckart, and Traube in the former species; Alex. Agassiz in *Autolytus cornutus*; Schmarda in *Catenula*; and Lankester in *Chætogasta*, show how widely this mode of development has been recognised. The feature that mainly concerns us at present in regard to these descriptions is the fact that a new animal is produced in a line with the old by various modifications of budding. In no instance is there any approach to a branched condition by lateral offshoots from either parent stock or bud. As an example of one of the best known marine forms, the account of *Autolytus cornutus* by Alexander Agassiz may be cited. This species exhibits a kind of alternation of generation, the parent stock (which is a sexual) giving rise posteriorly to male and female buds which differ much in appearance from each other. The latter produce ova, which by and by develop in the peculiar body-sac into a swarm of parent stocks with which the cycle commenced.

The discovery of a species (*Syllis ramosa*) of the same family (*Syllidæ*), which forms an intricate series of branches by lateral budding of the parent stock, by Sir Wyville Thomson in a hexactinellid sponge from Zebu, is one of the remarkable results of the *Challenger* expedition.

A detailed account of the animal then followed, and the remarkable absence of all trace of a head prominently noticed.

Embryology of Gymnadenia conopsea, by F. Marshall Ward.—The researches of the last two years, especially of Strasburger[1] and Warming,[2] and also of Vesque,[3] have yielded results sufficiently at variance with the older ones to warrant a serious reconsideration of the whole question of homologies. The main points may be put somewhat as follows:—

The embryo-sac is not the result of simple enlargement of one cell; a cell of an axial series of the ovule enlarges and cuts off two or more cells from its apex—the remainder becomes the embryo-sac,[4] and causes dissolution of the others as it enlarges, their remains persisting as refractive caps for some time. The protoplasmic contents of the embryo-sac separates into two chief masses, which pass to the opposite ends of the enlarging sac, a large vacuole forming between. Each mass then suffers division into four by planes cutting one another at right angles. In this way eight nucleated masses of protoplasm without cell-walls arise, three of which remain at each end of the embryo-sac, while one from each end wanders towards the centre of the sac and there fuses with its neighbour to form the nucleus of the sac.

Of the three anterior nucleated masses, two become elongated, fit into the top of the embryo-sac as the "Gehülfinnen," or "synergidæ" of Strasburger, and are probably what Schacht described as the "filiform apparatus"; their function is somewhat obscure, but appears to be related to the act of fertilisation between the end of the pollen-tube and the third nucleated mass, which has rounded off as a large bright egg-cell or ovum, and is suspended from the base and sides of the "Gehülfinnen."

The three posterior masses may not become completely isolated, or they may remain passive, or some may disappear, or they may multiply by division. Where endosperm is formed they appear to enter into its formation.

The author finds in Gymnadenia,[5] Butomus, Alisma, Anthericum, and Ranunculus ovules, confirmation of these views.

[1] "Ueber Befruchtung u. Zelltheilung," and "Die Angiospermen u. Gymnospernem."
[2] *Ann. des Sc. Nat. Bot.*, 1878. [3] *Ann. des Sc. Nat. Bot.*, 1878.
[4] Vesque, however, thought a fusion of at least two superposed cells produced the embryo-sac.
[5] Strasburger has partly worked this, so far as the first divisions of the embryo-sac mother-cell are concerned. He also gives figures of Anthericum. Vesque's account of Butomus is not supported by the author's drawings.

With reference to Warming,[1] and Vesque's[2] view that the origin of the embryo-sac is comparable to that of the mother-cell of pollen, and that the eight nucleated masses arranged in fours are therefore homologues of pollen grains (*i.e.*, spores), the following facts are of importance, as failing to support the theory:—1. The diffluent cell walls which form between the cells cut off by the embryo-sac mother-cell, are in no way important on account of their resemblance to the diffluent walls in pollen formation; they also resemble the diffluent walls formed in the suspensor (pro-embryo), or any other organ rapidly absorbed, &c. 2. The division into fours by planes crossing at right angles is common to many other processes besides pollen formation, *e.g.*, the embryo itself. 3. Vesque's view as to the embryo-sac arising by fusion of several cells is not supported by the existence of the remains of the *two cap cells* above the embryo-sac—the remains of the supposed fusing cells.

Comparison of the Effects of the Frosts of 1860–61, *and of* 1878–9, by E. J. Lowe, F.R.S.—The greatest cold of 1860 exceeded that of last winter by 10°; it was 6° below zero in 1860, and 4° above zero in the late frost.

The present paper records the great difference in the effects in the two frosts at Highfield House, Nottingham:—

Name.	Frost of 1860.	Frost of 1878.
Acacia (long spined)	Slightly injured	Many boughs killed and was a month later coming into leaf.
Elm (broad leaved)	Uninjured	Three-quarters of boughs killed back at least 2 feet.
Bay (sweet)	Killed to the ground	The ends of the shoots only killed and all the leaves.
Deodar cedar	Became deciduous, otherwise uninjured	Not injured.
Arbutus	Killed to the ground	Half the branches killed, the others injured.
Aucuba	" "	Uninjured.
Pampas grass	Killed	Killed.
Araucaria imbricata	Killed to where buried in the snow	Uninjured.
Yew	Slightly damaged	Slightly damaged.
Wellingtonia gigantea	Much injured	" "
Evergreen oak	Many killed, all became deciduous	Uninjured.
Ivy	More or less injured	More or less injured.
Fennel	Uninjured	All killed.
Sage	Killed	Uninjured.
Roses (standards)	All killed	Many killed, nearly all injured.
" on their own roots	Many killed	Uninjured.
Retinospora obtusa	Killed	"
" *squamosa*	"	Slightly injured.
" *leptoclada*	—	Uninjured.
" *ericoides*	—	"
" *filifera*	—	"
" *plumosa*	—	"
" *plumosa argentea*	—	Slightly injured.
Juniperus excelsa	Killed on the north half of the tree	Uninjured.
" *chinensis aurea*	—	"
Phornium tenax	Killed	Only killed to the ground.
Eugenia ugni	"	Half the branches killed.
Yucca gloriosa	"	Slightly injured.
Cineraria maritima	"	Killed.
Laurel, common	Many killed to the ground	Uninjured.
" Portugal	Nearly all killed	"
Holly	Most killed in the branches to the height of 7 feet	"
Thuja aurea	Mostly killed	Slightly injured.
Cork tree	Killed	—
Deutzia gracilis	Scarcely injured	Uninjured.
Quince	Killed	—
Yew, golden	Slightly injured	Uninjured.
Pinus insignis	Killed	"
" *pigmy*	Slightly	"
" *menziesii*	Became deciduous, and had no leaves for a year	"
" *morinda*	Slightly injured	"
Laurustinus	All killed	"
Abies Nordmanniana	Uninjured	Lost half its leaves and some boughs.
Walnut	Boughs killed and one tree	Uninjured, except a want of vigour; leaves only half the usual size.
Apples	—	Leaves small, fruit scarce and remarkably small.

[1] *Ann. d. Sciences Nat.*, 1878. [2] *Ann. d. Sc. Nat.*, 1878.

The above will sufficiently illustrate the effects of the frosts in two severe winters.

It is worthy of remark that instead of cold killing the slugs and various pests of plants, they were never known so numerous. Many hardy plants in pots were killed, such as ivy, *Pteris aquilina*, &c., when they escaped if plunged in the ground.

Recent Additions to the Moss Flora of the West Riding of Yorkshire, by Charles P. Hobkirk, F.L.S.—After treating of the work of the Yorkshire Naturalists' Union, in investigating the fauna and flora of the country, the author particularised some of the chief species found since 1873, and gave the history of them, viz., *Seligeria tristicha* at Littondale; *Aulacomnium turgiaum* at Whernside; *Fontinalis gracilis* at Malham Cove; *Plagiothecium nitidulum* at Penyghent, &c. Four lists were appended to the paper, viz.: (1) New species, 48; (2) Species found in fresh localities, 142; (3) Localities previously known, but not recorded, 29; and (4) Species inserted in error in pre vious list, 8; making the total number of species now recorded for the Riding, 327.

Department of Anthropology

Flint Implements from the Valley of the Bann, by W. J. Knowles.—I have obtained within the last three or four years, from the banks of the River Bann, a series of flint weapons or tools which differ considerably in type from the ordinary flint implements of the North of Ireland. They have been obtained from a deposit of diatomaceous earth used for brickmaking, near the town of Portglenone, and are of two types. That which is most numerous appears to have been made by splitting up nodules into halves and quarters, and then forming these into rude pointed implements by a process of coarse chipping. This kind numbers upwards of fifty, and they all agree in having a cutting point and thick base for holding in the hand. They are as a rule long, narrow, and of a cylindrical form rather than broad and flat, but some of the latter kind occur. Some of the largest are 7 or 8 inches long and from 2 to 3 inches broad at the base, and there is one fine implement of the flat kind, very like the triangular palæolithic implements, which is 6 inches long, nearly 4 inches broad at the base, and 1½ inches thick. Dr. Evans, in "Stone Implements and Ornaments of Great Britain," mentions that he has found implements of palæolithic form on the shores of Lough Neagh, near Toome, and I have also found them there myself, but as Toome is only a little farther up the Bann, and the diatomaceous earth is found there, I believe they have been derived from that deposit by denudation.

The second set of objects may be described as large triangular flakes with a central rib down the back, and having the base wrought into a tang. In the Catalogue of the Royal Irish Academy this form of implement is represented in Fig. 3, the tang being looked on as the first step of development into arrow- and spear-heads; but I am of opinion that instead of showing a step towards greater perfection, these were perfect implements of their kind, and also manufactured specially for use about rivers.

There is no means of determining the age of these objects except we form some sort of estimate from the fact of their being found in a deposit underlying peat. If they are of neolithic age they are very interesting from being confined chiefly to a river valley, and not being obtained where other neolithic implements are found in abundance. This fact would, I think, suggest a reason for the large triangular flints of palæolithic age being chiefly confined to the old river gravels, while the implements of the same age from the caves are so different. The implements of the pointed kind in all cases might not be for general use, but chiefly for the river valleys. They may probably have formed weapons for attacking the larger animals when they came down to drink, but the theory that they were used for breaking holes in ice I think a very likely one. I believe the tanged flakes were used mounted probably for spearing fish, as suggested by Dr. Evans in "Archæologia," vol. xli. p. 401.

On the Relations of the Indo-Chinese and Inter-Oceanic Races and Languages, by A. H. Keane, M.A.I.—The conclusion arrived at by the author, is that, excluding the dark races, there are in the Indo-Chinese and Inter-Oceanic area two fundamentally distinct racial types only—the yellow or Mongolian, and the fair or Caucasian; and corresponding to them two fundamentally distinct forms of speech only—the monosyllabic spoken *vario tono*, and the polysyllabic spoken *recto tono*. All the rest is the outcome of incessant secular interminglings.

Mr. Sydney B. J. Skertchly, F.G.S., H.M. Geological Survey, read a paper *On the Evidence of the Existence of the Palæolithic Man during the Glacial Period in East Anglia*. The object of the paper was chiefly to record the sections in which the author had discovered palæolithic implements beneath the chalky boulder clay in East Anglia. He said:—"The beds which yield the implements are a series of loams, clays, and sands, to which the author has given the name of Brandon Beds. They occur at the top of the middle glacial series of Messrs. S. V. Wood, jun., and F. W. Harmer, and underlie the chalky boulder clay or upper glacial of the above-named authors. They have yielded palæolithic instruments in many places, but only those will be described in which the chalky boulder clay overlies the Brandon Beds at the present time. Near Mildenhall, on the River Lark, in Suffolk, two sections have yielded implements. They are at Warren Hill and Mildenhall Brickyard. The section at Warren Hill is as follows:—1. Sandy soil, &c., two feet. 2. Chalky boulder clay six feet. 3. Gravel four feet. 4. Loamy clay four feet. 5. Boulder clay six feet. 6. Chalk. This spot has yielded great numbers of flakes and many implements. It was originally described by Professor Prestwich, but the boulder clay has only recently been exposed above the tool-bearing loams. At Mildenhall Brickyard the section is—1. Sandy soil one foot. 2. Chalky boulder clay six feet. 3. Loam ten feet. 4. Chalk. From this place many implements and flakes have been obtained. They occur in the loam. Culford in Suffolk: The Brandon beds are here dug under fifteen feet of solid boulder clay; from these I obtained two flakes. West Stow, in Suffolk: Boulder clay overlies, underlies, and wraps round the Brandon beds at this place; some well-worked implements have been obtained, one of which was dug out by the author. Brandon: Near Brandon the same beds are being dug beneath boulder clay, and have yielded very good implements. The peculiarities of the implements are pointed out, and the mode of distinguishing them from specimens from the gravels is indicated. The author in this paper merely desires to emphasize the fact that from several sections he has himself dug out palæolithic implements from below tough, undisturbed chalky boulder clay. These proved the existence of man in these districts previous to the glacial periods.

The Chairman said that if Mr. Skertchly's facts were sound and his inferences well warranted it was obvious to all the matter was one of the greatest importance. He invited discussion.

After some remarks from Dr. John Evans, Prof. W. Boyd Dawkins (Manchester) said there was no evidence that the glacial period was to be looked on as a dividing line in classification. He fancied that all the animals that were living after that period of extreme cold had passed away appeared in Europe before that cold was felt, and he could not therefore, look on the glacial period as a hard and fast line. It seemed to him if they applied that consideration to the examination of the question of the antiquity of man there was no *à priori* reason for supposing that man was not here in the pre-glacial age. Seeing that animals were living in Europe before the cold period arrived at its maximum, it was probable that man was here too. Man was living in the south of this country when the area north of the Thames was submerged—when the sea there was bearing icebergs which were accumulating the boulder clay.

Sir John Lubbock, said that as geologists they must be careful before they came to any definite conclusions on a matter of this importance. He confessed that after listening to the paper which they had just heard he felt considerable difficulty in resisting the conclusions which Mr. Skertchly had drawn from the facts. He thought there could be no doubt that the implements before them were the work of man.

Professor Huxley said that without the slightest desire to discourage the excellent efforts Mr. Skertchly had made, he confessed he could not attach any great importance as to whether those particular deposits were post-glacial, inter-glacial, pre-glacial, or how. There was not the slightest doubt that at the end of what was commonly recognised as the tertiary period there was a time in which the climate of this country became extremely severe—there was a great formation of ice. There was no doubt that the animals which existed in this part of the world immediately before that deposit, were practically the same as those just after. If they looked at the glacial epoch as a period

of duration of animal life—the period it occupied was totally insignificant in regard to that which they would require for the evolution of man to his present state. There could not be the slightest reason for supposing that pre-glacial man was in any way different from post-glacial man. No doubt, whatever habits of life were adopted during the cold period, were adopted before that cold fairly set in. As the people lived like Equimaux during the whole of the cold period, and for some time afterwards, he could not see why they should not have lived in that fashion for some time before. There could not be a doubt in any reasonable man's mind, that the remains of man discovered in the older part of the glacial deposit were the same as those in the new. The evidence Mr. Skertchly had brought forward was very satisfactory, but he confessed he did not see why it should not be so.

Mr. Skertchly read a paper *On a New Estimate of the Date of the Neolithic Age.*—The Fenland occupies an area of 1,300 square miles around the great bay of the Wash. The surface of the inland portions consists of peat, and that of the seaward parts of marine silt. This silt is still in process of deposition, and the land is consequently gaining upon the sea. From the time of the Roman occupation, at least, banks have been successively erected to reclaim the newly-formed ground; and as the dates of these banks are known, very accurate estimates can be formed of the rate at which the deposition is going on in different parts. The maximum rate is fifty-nine feet per annum, and four miles of new land has been formed since the oldest banks were erected. These banks are generally ascribed to the Romans; but they are probably British. In this estimate they will be taken as Roman, in order that the age may not be over estimated, and the maximum rate of deposition will also be used as giving the minimum of time. The geological evidence shows that as the silting went on, and the area become converted into land, peat grew and gradually spread over the newly-formed ground. But in process of time the climate became unfitted for the growth of peat, which gradually lost its vigour, and finally ceased to form. Hence a wide stretch of silt land borders the Wash, upon the surface of which no peat has ever formed. The peat died upon its eastward march; the silt still travels on. The nearest approach of the peat to the banks along the line of most rapid accumulation is twelve miles distant therefrom. The age of this, the newest peat in the Fenland, can be thus determined. Between the "Roman" banks and the sea lie four miles of silt, which has taken 1,700 years to accumulate. Between these banks and the sea lie twelve miles of silt, which at the same rate of formation would take 5,100 years to accumulate. Adding 5,100 to 1,700 years, we have 6,800 years as the least possible age of the newest peat. This peat has yielded many neolithic implements, hence we may assume that 7,000 years will take us back into the neolithic age. The coincidence of this estimate with the two Swiss ones above-mentioned is remarkable. These results do not, however, give us the date of the introduction of the neoliths into Europe, for neither in the Swiss nor English localities are we sure that the neolithic relics belong to the early part of the neolithic age. The author, indeed, has recently obtained evidence of neolithic handiwork in Fenland peat of far greater age than that described, the peat bed underlying silt more than 7,000 years old. He is inclined to think that the neolithic age in England began at least 10,000 years ago, and perhaps 20,000 years; but that it does not approach the close of the glacial epoch seems to be shown by the fact that the older Fenland beds (themselves post-glacial) do not contain human relics.

Commander Cameron read an interesting paper giving a detailed account of the *Manners and Customs of the People of Urua, one of the largest Native States in Central Africa.* This particular race maintained many places in which religion was centralised. Kasango, the king or principal chief, was not merely a secular chief, but was also intimately mixed up with the religion of the people. He claimed divine praise, and at his death was buried with savage rites, and all his wives except one were slaughtered at his grave. This one remained to be the pythoness of his successor, and the spirit of the chief at his death was supposed to be transmigrated into the body of his successor. An idol was preserved in the middle of a dense jungle. He had for a wife one of the sisters of the reigning sovereign. Around about the jungle were the huts of a numerous class of priests, who received the tribute collected for that class of people. The only person allowed to sacrifice to the idol or to visit him except the idol's wife was the sovereign of the country. There was a numerous class of wizards who carried about with them small idols and a large stock-in-trade in charms, which they sold. Many of them were ventriloquists, and it often happened when they were consulted by the natives questions were asked which were communicated to the idol, and then the wizard, by the exercise of very poor ventriloquism, made the idol return an answer to the question put. The caste was very clearly defined in this race. The chief allowed none of his subjects to sit down in his presence without permission, and he seldom accorded it. No one of a lower grade could sit down in the presence of one of a superior grade. The customs in eating, drinking, and cooking were various. They declined to eat in the presence of each other, and, although fond of the native beer, they would not drink it while anybody was looking on, although it was sufficient to hold up a cloth as a screen. All the different castes and ranks were marked and distinguished by their dress. The attire was very simple, consisting usually of an apron. They were not a hairy race, but managed to grow their beards very long, and they plaited them after the manner of a Chinese pig-tail, winding up with a ball of dirt at the end to make it hang down straight. The women were tattooed most extensively. The means of communicating news was by drums and messengers. The men could run very fast. One man, for instance, brought him a message from the king, having come a distance of between 50 and 60 miles in a period of six hours. By means of certain beats on the drum messages could be sent immense distances, and answers immediately returned. In time of war the king could send messages to a great distance, either to bring up his forces at once, or to say that he was returning and that they were to go back.

Major Serpa Pinto read a paper *On the Native Races of the Head Waters of the Zambesi.*—He said they there found people whose complexion, as compared with his, then bronzed with an African sun, was white, yet they were negro in feature. There were also mixed races in that part of the country, with complexions of a whitish cast, yet with negroid features. The whole matter seemed to indicate in a most puzzling way the mixture of races. In the Bihé district, that portion of the population had, for the most part, made its appearance during the last century. It was not a pure African, but probably a mixture with the races which came over for elephant hunting purposes. The pure African type, of course, was the flat nose, large lips, and frizzled hair; but there had been some modifications in this instance with regard to feature. He declared that he had seen girls in that part of the country who, if their complexions had been more like that of the Europeans, would have passed for beauties here.

M. Brazza read a communication *On the Native Races of the Gaboon and the Ogowé.*—Major Pinto, he said, had spoken of races having European characteristics. He was of opinion that those people had come from the North of Africa, because under the name of Ubamba he had found races very much resembling them to the south of the Congo. The negroes Major Serpa Pinto saw were probably the advanced guard of an invasion which had overrun the country to the east of the Gaboon. Stanley spoke of a great emigration, very much resembling what had taken place among the Fan cannibals. There had been much talk indulged in adverse to the cannibal races of this part of Africa. Du Chaillu, who had visited for one day only one of the Fan villages, had given a description of this race which had been too much influenced by accounts he had received from a tribe at war with the cannibals. He had said that in their villages he had found quarters of human flesh exposed for sale; that they killed and ate their prisoners of war, and that they sold the bodies of their own dead who had died of disease to their neighbours. M. de Brazza denied the truth of such accounts. As a proof that the Fans had kindly and generous sentiments he told how a Fan chief had been kind to him when he was obliged to leave his people sick in the bush. He owed his life to the Fan chief, and he should always be grateful to him and his people. He wished therefore to do all he could to remove the prejudice against the Fans which had been excited by Du Chaillu. They were a very generous, courageous people. It was true they were cannibals—that they ate their prisoners of war; but it was with them a religious idea, for they believed that in eating the heart of a brave man the courage of the dead passed into themselves. M. de Brazza also gave an interesting sketch of the Akkas, a dwarf race he found scattered up and down among the different peoples, like what the Jews or the gipsies were in Europe. The height of the Akkas was from three to four feet.

Mr. V. Ball, M.A., of the Geological Survey of India, in continuation of some remarks make on this subject at the last meeting of the Association in Dublin, gave an account of the results at which he had since arrived from an examination of all the available data. These were that the three classes into which the stone implements might be grouped occupied independent geographical tracts which overlapped one another towards the centre of the peninsula. The geographical tracts characterised by the prevalence of one or other of the particular forms when laid down on a map showed a remarkable coincidence with the limits of the areas of distribution of the non-Aryan races belonging to the several families whose waves of imigration had contributed to form the lower strata of the population. Thus the manufacturers of the polished Celts were identified with the Kolarian races who entered India from the north-east and Burmah. On the other hand, the manufacturers of the flakes and cores of flint, &c., appeared to have entered the peninsula from the north-west, and to have belonged to the Dravidian family. The identity of the manufacturers of the chipped quartzite implements which were found in Southern India, was less clear, but suggestions regarding it were also offered by the author.

SECTION E—Geography

Mr. C. E. D. Black, read a paper *On the Geography of the Upper Course of the Brahmaputra.*—With especial reference to a recent important exploration of the easternmost portion of its course, made by one of the native explorers attached to the Indian Survey Department of this piece of work, though executed in 1877, no description had reached Europe, and its communication for the first time to the British Association was therefore a geographical event of very great interest. Mr. Black commenced by tracing the topography of the great Sanpee river from its source 13,000 feet above sea level in Western Tibet, over lofty plains, past the towns of Janglache, Shigatze, to the furthest eastern point to which it had been traced by the famous Indian explorer, Pundit Nain Singh, noticing *en route* the remarkable hot springs in the valley of one of the northern tributaries, the Shiang-chu, and the various rivers which join it on the left and right banks. The plain and city of Lhasa, the residence of the Dalai Lama and of the Chinese governors or agents, was described, as well as the amusing incidents accompanying the transit of the river on the occasion of that eccentric traveller, Mr. Manning, proceeding to Lhasa. From Chetang eastward commenced the new work of the explorer, N——g, who had been commissioned by General Walker, the Surveyor-General of India, to explore the course of the Sanpee for as great a distance as possible. Crossing to the north bank of the river, he followed it for a distance of 30 miles, nearly to the confluence of the Milk-chu, a small stream. Here he diverged to the north-east, making a detour of 50 miles, while the river wended its way for 20 miles through impenetrable mountains. The most remarkable feature of the exploration was the discovery that the river made a huge bend northwards before commencing its south-eastern course into Assam. This bend was actually surveyed by the explorer. From his furthest point to the highest known point of the Dihong, an unsurveyed gap of about only 100 miles now remains. Mr. Black concluded by pointing out that this great bend, which was previously unknown, now leaves room for a northern feeder of the Subansiri, and thus accounts for the large bulk of the latter river. Mr. Black also cited some important corroboration of this new fact, afforded by the Abbé Desgodins' researches, and by the recent measurement of the discharges of the large rivers of Assam by Lieut. Harman, R.E.

Prof. P. J. Veth, president of the Dutch Geographical Society, contributed a paper, giving interesting details of the *Dutch Expedition to Central Sumatra.*—The most important result of the expedition was the gain in knowledge of the great extent and capabilities of the Batang-Hari, which is found to be about 210 miles in length in a straight line, and over 490 miles following its windings, being in fact larger than the Musi or Palembang, hitherto considered the only large river in Sumatra. It is practicable for small prahus, used in transport of merchandise, for 480 miles; and the steam launch drawing 3½ feet could navigate it for 370 miles, both these distances far exceeding the navigable portion of the Musi. Its tributaries are also navigable for boats, and one of them at least for the launch. The population of its district as a whole is scanty, yet there are numerous villages close to each other; cattle abound in the highlands, and coffee is largely cultivated in Karinchi. The importance of the river as a highway for the eastern parts of the West Coast Government and the inland districts of Jambi and Karinchi does not therefore merely depend upon its fitness for transport of coal from the Ombilin Valley.

A paper by Major Pinto was read *On his Journey across Africa*, in which, though he did not tell much that was new of his exploration, he referred to one or two points of some scientific importance. He was desirous of calling the attention of the Section to the manner of determining the longitudes by the eclipses of the satellites of Jupiter, and he suggested a means of overcoming an obvious difficulty. Let it be resolved, he said, that in one of the many official observatories that had the support of Europe the eclipses of the satellites of Jupiter be studied without interruption, and the solitary explorer, lost, so to speak, in the enormous solitudes of the dark continent, when he in the obscurity of night saw the little brilliant speck disappear, would know that in a position perfectly determined some other person likewise at that same moment saw the small satellite disappear, and he will have the consciousness that on his return to Europe he will meet with the necessary elements to determine as many strictly correct longitudes as were the observations he might have made. When the planet was in conjunction the telescope might be turned toward the star that hid itself, or by making a series of apozenites of the moon they would obtain their longitudes. Any explorer of tropical Africa once provided with the aba and a telescope of 4 feet focal distance would find himself in a position to determine two of the co-ordinates and any variations of the compass. Major Pinto further recommended the hypsometer and aneroids for altitudes. Major Pinto gave a short *résumé* of the meteorological conditions of the Zambesi. He explained that the banks of the upper part of the river were of a fine and white sand of a remarkable character; when trod upon it produced a queer sound resembling somewhat the crying of a young child. The range of the Catongo mountains was well peopled on the westward, and it was there the Barotzes made their plantations, which consisted of maize, sweet potatoes, pumpkins, and mandisca. The great plain was not availed of for agriculture. Around the lakes and some other places a kind of grass grew, upon which thousands of oxen might be seen grazing. The Luinas followed the calling of shepherds. Horses could very easily be bred there, and the Barotzes possessed a splendid specimen of hounds, with which the natives hunted the antelope. The human race at present populating the country was a true mixture of the Lobares, Luinas, and Janguellis. The makalotus had now disappeared completely. Polygamy prevailed, and, contrary to what occurred in most other tribes, women who were held to be noble enjoyed high consideration and were sometimes invested with the exercise of public functions. The Barotzes possessed a tolerable quantity of firearms, but their natural arm was the assegai. They were rather industrious and good tanners, but did not use the knife, doing all their work with the blade of the assegai.

SECTION F—Economic Science and Statistics

Papers were read in this Section by Dr. Gladstone *On Elementary Natural Science in the Board Schools of London*, by Mr. Miss, of the Sheffield School Board, on a similiar subject, and by Mr. Hance of the Liverpool School, Board, describing the successful efforts made by them in science teaching. In the interesting discussion which followed, Mr. F. Wilson observed that what they required was the introduction of the science of perception. A child could see a thing and not always perceive it, therefore it was most essential that they should teach scholars to perceive and so obtain a system of order.

Dr. R. Wormell remarked upon the importance of having teachers who knew something about the teaching of science in the beginning, and spoke of the necessity of a college where teachers could be instructed in order to carry on the work of scientific teaching. There were 1,600 young men entering the training colleges every year, and at least 100 of these would do better as teachers of science than of other subjects. Scientific education ought to find its way into all schools from the earliest stages to the most advanced. The Kindergarten system was a fair beginning, but it was too restrictive. Observation and experiment were the means by which truth had to be discovered, and when science was taught simultaneously with other subjects

they would find that the intelligence of the pupils was heightened, and that their skill in manipulation, and ability to use their hands, would increase, no slight point when it was remembered that the manufacturing population were educated in these schools. It would, in his opinion, help such bodies as the London School Board, who were anxious for this scientific teaching, if the British Association had a permanent committee to consider the question and give assistance if required.

The Rev. A. Harland referred to the difficulties of teaching natural science in the country school. It was not only necessary, he said, that our teachers should have a thoroughly scientific knowledge, but that the inspectors of the schools should also possess it. So little encouragement had the inspector given that he had even told them in their school to drop such subjects as botany, and to confine their attention pretty much to the three R's. He had, however, an evening with the village children, when he tried to give them some knowledge of chemistry and physiology in order to show them the evils of intemperance, and he thought this was much better than making them commit to memory silly recitations, as was the practice in some Bands of Hope.

Miss Becker (Manchester School Board), after remarking that the question of giving children scientific teaching was only valuable as to the help it would give them in making their way through the world, said she was sorry the science of mechanics was confined to the boy's school because any girl or woman who had to do household work was painfully conscious that she had frequently to move weights, and if she understood the principles of mechanical science it would be far less laborious and less painful—in fact, the principle of the lever was of the utmost consequence in domestic economy. The scrubbing of a floor, and the carrying of a coal-box were mechanical operations which were much better done on scientific principles. Animal physiology had a very close relation to the infant's organisation in its most tender stages, and in the interests of the babies she did think it most important that the common elementary principles of physiology should be known to their mothers.

After some further remarks by Miss Becker, showing the value of a knowledge of science in the commonest duties of every-day life,

Prof. Silvanus Thompson spoke of the advantage of apprenticeship schools, but said that if such schools were established in England it would be by local, rather than Imperial effort, for they succeeded better when they were not fettered by Imperial legislation. Whatever science teaching existed was not merely a scrap, but part of the organic whole, and this was sufficiently elastic to allow of there being special schools, a building school, a school of carpentry, a school for other kinds of technical education, all having their base in the elementary schools; but there should be more community of idea between the lower and the higher scientific training. Miss Becker had affirmed that children seven years old ought to be able to read perfectly if they were scientifically taught, but they were not scientifically taught, nor did he think the difficulty would be removed until they had done away with the abominable irregularities of the detestable English spelling, and reformed the table book.

The Rev. W. Delaney (St. Stanislaus College, Tullamore) said he should like to change the idea that science was merely the handmaid of education, for he believed it was really the best educational weapon, and as a schoolmaster he valued almost infinitesimally the knowledge that boys and girls, and even university men, carried with them into life. Education hitherto had gone too much in grooves, and what they required was a great improvement in scientific teaching, especially in intermediate schools, where it was in a deplorable state. He found that boys who could learn nothing learn science easily, and that when they had learnt science they could learn other things easily. There was an absolute inutility and absurdity in teaching grammar in which boys were taught to know the unknown by the unknown, and he found moreover that whilst Latin and Greek were well known in scientific schools, scholars simply studying the classics often failed in that special study, whereas those who studied science as well as classics passed often at the head of the list.

The President (Mr. Mundella) in summing up the discussion, said he believed that science teaching tended to redeem school life from its drudgery and monotony. In the science schools abroad the interest manifested by the children in a proper object lesson, and the facility with which they acquired knowledge, had very much struck him. The step which, above all others, was the most necessary in education was to awaken the interest of the children in the subject taught. The children would be taught to think for themselves. Therefore, he had always supported science teaching in schools not only for its great utility, but from a belief that if science teaching was coupled with the ordinary literary teaching of schools, a knowledge of the literary subjects would be more easily acquired. It did not surprise him to hear that there was a good deal in our national education system that needed reform. They had just heard from a successful and accomplished teacher in this town that science could not be taught, because the inspectors themselves discouraged the teaching of it. Young gentlemen fresh from the Universities—some of them very accomplished—were made the inspectors of the whole elementary schools in the country, by a system of patronage and not of selection. They were very highly paid, and they were appointed inspectors because perhaps their fathers or near relatives had rendered a service to some particular political party whichever it might be. But that was altogether a wrong state of matters with reference to education. In London he was now constantly hearing a cry as to whether we are not over-educating the people. Although all present might acquiesce to-day in this discussion, throughout society the cry was, "We are over-educating our people." The real truth was, that people had yet to learn to begin to educate children. They were all very proud of what had been done by the Education Act of 1870, and he should be the last man to undervalue that Act. But as for having an educational system, he declared they had none. To begin with, they should have a Minister of Education who would deal with education solely, and who would know something about his business. Education ought not to be mixed up in the Education Department with vaccination and cattle plague, and other things. It seemed that all the heterogeneous things there was no room for in other departments had been sent to the Education Department. He not only supported science teaching in schools, but he wanted to see it carried to a higher state than the mere teaching of it in schools. Should the British Association visit this town some twenty years hence, they might reasonably expect to find "home-bred" scientific men who would appreciate more highly the Association's labours.

Several important papers on Afghanistan were read in this section by officers and others who had been with the English army in the recent Afghan war.

Mr. William Simpson, the special artist of the *Illustrated London News*, read a paper, entitled *Afghan War—the Jellalabad Region.*—The tendency of his explorations, beyond his own proper sphere as an artist, was rather archæological than geographical. No account of the Jellalabad Valley would be complete without some notice of the Buddhist remains to be found there. He was aware previously of the existence of these remains, but what astonished him was the vast quantity of them still to be seen. On all sides are extensive mounds and heaps, that being the condition in most cases of these remains. Here and there structures may be found, which, although in ruins, yet bear on them some traces of architecture. One point is apparently clear, that in the Buddhist period the population of the Jellalabad Valley must have been much more numerous than at present, and that the area of cultivation must have been also more extensive. Major Cavagnari supplied the author with a working party to make excavations at the Ahin Posh Tope, about a mile south from Jellalabad. The principal object was to explore the architectural details of the remains, but while thus engaged, the author penetrated, by means of a tunnel, cut for about 45 feet through solid masonry, to the central shell of the shrine, and found along with what were most probably the ashes of some Buddhist saint of high repute, twenty gold coins, each about the size of a sovereign. Seventeen of these were Bactrian, or Indo-Scythian; and three were Roman.

Major Campbell described the *Shorawak Valley and the Toba Plateau in Afghanistan.*—The Shorawak valley had never been visited by Europeans before the recent campaign. It is a narrow strip of flat country lying between the desert on the west and north-west, and a range generally known as the Sarlat Hills to the east. Its total length is about 40 miles, with a width of 10 miles at the northern end; and it is 3,250 feet above the sea. The head of the valley, to the north, is closed in by the southern spurs of the Khwaja-Amran range of mountains, which nearly join the north-western spurs of the Sarlat Hills, only leaving a gap of about a mile through which the Lora river runs into the valley. The valley is thickly populated, and crops of wheat and barley are raised. Major Campbell suggested that Shorawak was once a lake, which was gradually silted up by deposits from the Lora, and this seems to account for most

of the phenomena. The river, after flowing through the valley, is swallowed up in the sand of the desert. The Toba tableland is at the north-eastern extremity of the Khwaja-Amran range of mountains. The general elevation is over 7,000 feet. Major Campbell gave an interesting account of this plateau and of its inhabitants. It will probably form an excellent hill sanatorium for the troops stationed in the Pishin Valley. The climate of the plateau in summer is very pleasant.

Papers were also read *On New Routes to Kandahar*, by Captain Haldich; *On Surveys Around Kandahar*, by Captain M. Rogers, R.E.; and *On the Orography of the North-West Frontier of India*, by Mr. Trelawny Saunders.

Mr. Black read a paper, which had been contributed by Mr. J. O. N. James, deputy superintendent of the Surveys of India. The object of the paper was to sketch out, in a concise manner, the nature of the work in progress and already performed by the Indian Survey Department, and to point out its practical utility. During the administration of Sir Henry Thuillier, late Surveyor-General of India (1861 to 1877), an area of not less than 290,000 square miles was surveyed and mapped, including the wildest and least known tracts of India. This enormous area, more than double the size of Great Britain and Ireland, was surveyed in sixteen years at an average cost of 2*l.* per square mile. Also an area of 493,000 square miles was completed on the village survey system on a scale of four inches to the mile, and 12,281 square miles by cadastral measurement on a scale of 16 and 32 inches to the mile; making an aggregate of 505,574 square miles, considerably more than double the area of France. The revenue surveys comprise a great portion of Bengal and Assam, all Oudh, part of the North-West and Central Provinces and Bombay, nearly all the Punjab, and all Sind. There is not a single official in India who does not possess maps of the portion of the country included in his jurisdiction, which are suited to every present requirement. The maps issued by the Surveyor General's Department are also utilised by engineers in the construction of public works, by the foresters for conservancy purposes, by mining companies, planters, holders of estates, and by every branch of the civil and military services for purposes too numerous to detail.

Prof. S. P. Thompson read a paper *On Apprentice Schools in France*.—The problem to be solved was—how to give that technical training and scientific knowledge to artisan children which their occupation demanded, without detaining them so long at their schooling as to give them a distaste for manual labour. There were four solutions of the problem, all of which had been tried, and illustrations of which could be seen in Paris. They were (1) send the children to work in the factory or workshop at an earlier age, making it obligatory all through their apprenticeship that they should have every day a certain number of hours' schooling in a school in the workshop or attached to it. (2) Keep the children at school as long as their education was unfinished, but set up a workshop in the school where they should pass a certain amount of time every day so as to gain at least an aptitude for manual labour. (3) Organise a school and a workshop side by side and co-ordinate the hours given to study with an equal number of hours devoted to systematic manual labour; and (4) send the children half the day to the existing schools, and the other half to work half-time in the workshop or factory. Schools of the first type had existed in France for nearly thirty years, and at the close of 1878 there were no fewer than 237 schools of this character. So far as he was aware, there was only one school of the second type—the Ecole communale d'Apprentis, in the Rue Tournefort, Paris. The peculiarity of this school was that workshop training was being given to lads who had not yet completed a course of elementary education. Of the third type some admirable examples were to be seen in Paris. Some very interesting particulars were given of the progress of the horological school at Besançon. The fourth type or half-time school, which was English in its origin, was rarely to be found in France. Since the old apprenticeship had virtually lapsed, there was nothing to save the young artisan of the rising generation from degenerating into a mere machine, unless a new agency could be practically organised. What was claimed for the apprenticeship school was that its pupils do not possess just a bare minimum of knowledge sufficient to procure them means of subsistence in one narrow department of one restricted industry, but that they possess both manual dexterity and a fair technical knowledge which would enable them not only to earn more and to turn out better work, but also to be less at the mercy of the fluctuation of trade for the means of subsistence. Besides the new apprenticeship being better for real instruction in technical principles, it was also better for practical work in so far as it shortened the needlessly long years of the apprenticeship, and imparted at an earlier age all the manual capacity that apprenticeship in any form could impart. There were not wanting on our horizon signs of significance in the problem of the relation of science to labour. We had really skilled workmen, and no foreign workmen were their equals, but they were only units in a crowd. Take which view they would, technical education, and above all, the technical education of the artisan classes was a *sine quâ non* of the future industrial prosperity of Great Britain. What steps then must be taken to give effect to the new apprenticeship? Two things would determine the success or failure of the school—(1) the obtaining of the right kind of teachers, and (2) the adoption of a system of instruction based upon drawing, which was the language of the manufactures, the handicrafts, the constructive industries of all kinds. It was evident that the first step would be the foundation of a system for training competent teachers. Then there must be a central technical college, for through such an institution alone could community of thought and method of work be obtained. If such a system of technical education as he pointed out was to be instituted, the nation must move towards its accomplishment with a spirit very different from that in which it had viewed technical education during the last quarter of a century. Crisis after crisis had passed, and capitalists and unionist artisans either would not, could not, or dare not confess that the core of all the rottenness was the failure of the old apprenticeship to cope with the requirements of the age and the new social conditions brought about by the fierce rivalries of industry.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE twenty-eighth meeting of the American Association for the Advancement of Science was commenced on Wednesday, August 27, at Saratoga Springs, N.Y. After the formal opening in the Town Hall, the proceedings of the first day were mostly concerned with organisation. We give below, in part, the address of the retiring president, Prof. O. C. Marsh, which was delivered on the evening of the 28th, and we hope shortly to offer further intelligence of the scientific work of the meeting.

The new President is Prof. George F. Barker, of Philadelphia; the Vice-president in Section A (comprising Mathematics, Astronomy, Physics, Chemistry, and Mineralogy), Prof. Langley, of Alleghany; and that in Section B (Geology, Zoology, and Botany), Major Powell, of Washington. Prof. Clarke was chairman in Chemistry (sub-Section C), Dr. Morley in Microscopy (sub-Section D) and Dr. D. Wilson in Anthropology (sub-Section E). In addition to the presidential addresses and ordinary work of the sections, we note from the programme that Dr. Edison was to give, on the Saturday evening, an illustrated paper on "The Electro-Chemical Telephone;" while Monday evening was to be devoted in general session to hearing three papers by Professors Chandler, Hall, and Hunt on the mineral waters of Saratoga. There is a goodly list of over 150 papers to be read before the various sections (and it is, by the way, a commendable feature, that the time each would occupy in reading is exactly stated). The following are, briefly, some of the subjects:—In Section A: Experimental determination of the velocity of light (Michelson); Cooling of the sun and the earth (Peirce); Solubility of ozone (Leeds); A general law indicating the location of planets, satellites, or annular rings round their primary (Marsden); Metrology and the progress of science (Barnard); Double stars (Hall); Identity of lines of oxygen with bright solar lines (Draper); Binaural audition (Bell); Conversion of mechanical energy into heat by magneto-electric machines (Barker); Phenomena of heating metal *in vacuo* by means of an electric current (Edison); Influence of light on electric conductivity of metals (Wright). In Section B: Succession of glacial deposits in New England (Upham); Histology of insects (Minot); Conditions to be fulfilled by a theory of life (Minot); Philosophy of the pupation of butterflies (Riley); Consonantal expression of emotion (Blake); Microscopic crystals in the vertebra of the toad (Bolton); The inter-oceanic canal problem (Lull); Bornean orangs (Hornaday); Objects of sex and of odour in flowers (Meehan); Remarkable crinoidal form recently found in Tennessee (Safford); New unpolarisable elec-

trodes for physiological research (Bowditch); Triassic rocks of New Jersey (Cook); Geological action of the acid of humus (Julien); Anatomy of the cat's brain (Wilder); Anthracite coal-fields of Pennsylvania, and their rapid exhaustion (Sheafer); Development of neuration in the wings of insects (Scudder). In sub-Section C: Reduction of carbonic acid by phosphorus at ordinary temperature (Leeds); Deterioration of library bindings (Nichols); Variations in temperature and chemical character of the water of Fresh Pond, Mass. (Nichols); Revision of the atomic weights (Clarke); Results of systematic analysis of air (Morley); Meteorological conditions of beet-root culture (McMurtrie). In sub-Section E: Superstitions of ancient inhabitants of the Mississippi valley relative to rabbits, serpents, owls, &c. (Henderson); Archæological notes from Japan (Morse); Ethnical influences of physical geography (Wilson); The sign language of the North American Indians (Mulbery); Archæology of the Champlain valley (Perkins); Ethnology of the islands of the Indian and Pacific Oceans (Bickmore); Pottery and stone implements of the southern mound-builders (Putnam).

Excursions were arranged to Luzerne, Lake George, Ausable Chasm, Howe's Cave, Montreal, Rutland, Port Henry, and Plattsburgh. On presentation of certificates, members could make free use of the wires of the Western Union Telegraph Company. They could also purchase at nominal rates tickets entitling them to all the privileges of the Congress Spring Park, day or night.

HISTORY AND METHODS OF PALÆONTOLOGICAL DISCOVERY[1]

IN the rapid progress of knowledge, we are constantly brought face to face with the question, What is Life? The answer is not yet, but a thousand earnest seekers after truth seem to be slowly approaching a solution. This question gives a new interest to every department of science that relates to life in any form, and the history of life offers a most suggestive field for research. One line of investigation lies through embryology, and here the advance is most encouraging. Another promising path leads back through the life history of the globe, and in this direction we may hope for increasing light, as a reward for patient work.

The plants and animals now living on the earth interest alike the savage and the savant, and hence have been carefully observed in every age of human history. The life of the remote past, however, is preserved only in scanty records, buried in the earth, and therefore readily escapes attention. For these reasons, the study of ancient life is one of the latest of modern sciences, and among the most difficult. In view of the great advances which this department of knowledge has made within the last decade, especially in this country, I have thought it fitting to the present occasion to review briefly its development, and have chosen for my subject this evening, THE HISTORY AND METHODS OF PALÆONTOLOGICAL DISCOVERY.

In the short time now at my command, I can only attempt to present a rapid sketch of the principal steps in the progress of this science. The literature of the subject, especially in connection with the discussions it provoked, is voluminous, and an outline of the history itself must suffice for my present purpose.

In looking over the records of palæontology, its history may conveniently be divided into four periods, well marked by prominent features, but, like all stages of intellectual growth, without definite boundaries.

The first period, dating back to the time when men first noticed fossil remains in the rocks, and queried as to their nature, is of special interest in this connection. The most prominent characteristic of this period was a long and bitter contest as to the *nature of fossil remains*. Were they mere "sports of Nature," or had they once been endowed with life? Simple as this problem now seems, centuries passed before the wise men of that time were agreed upon its solution.

Sea shells in the solid rocks on the tops of mountains early attracted the attention of the ancients, and the learned men among them seem to have appreciated in some instances their true character, and given rational explanations of their presence.

The philosopher Zenophanes, of Colophon, who lived about 500 B.C., mentions the remains of fishes and other animals in the stone quarries near Syracuse; the impression of an anchovy in the rock of Paros, and various marine fossils at other places. His conclusion from these facts was, that the surface of the earth had once been in a soft condition at the bottom of the sea; and thus the objects mentioned were entombed. Herodotus, half a century later, speaks of marine shells on the hills of Egypt, and over the Libyan desert, and he inferred therefrom that the sea had once covered that whole region. Empedocles, of Agrigentum (450 B.C.), believed that the many hippopotamus bones found in Sicily were remains of human giants, in comparison with which the present race were as children. Here, he thought, was a battle-field between the gods and the Titans, and the bones belonged to the slain. Pythagoras (582 B.C.) had already anticipated one conclusion of modern geology, if the following statement, attributed to him by Ovid, was his own:[1]

> Vidi ego quod fuerat solidissima tellus,
> Esse fretum: vidi factas ex æquore terras;
> Et procul a pelago conchæ jacuere marinæ.

Aristotle (384-322 B.C.) was not only aware of the existence of fossils in the rocks, but has also placed on record sagacious views as to the changes in the earth's surface necessary to account for them. In the second book of his meteorics, he says: "The changes of the earth are so slow in comparison to the duration of our lives, that they are overlooked; and the migrations of people after great catastrophes and their removal to other regions, cause the event to be forgotten." Again, in the same work, he says: "As time never fails, and the universe is eternal, neither the Tànais, nor the Nile, can have flowed for ever. The places where they rise were once dry, and there is a limit to their operations: but there is none to time. So of all other rivers; they spring up and they perish; and the sea also continually deserts some lands and invades others. The same tracts, therefore, of the earth are not, some always sea, and others always continents, but everything changes in the course of time."

Aristotle's views on the subject of spontaneous generation were less sound, and his doctrines on this subject exerted a powerful influence for the succeeding twenty centuries. In the long discussion that followed concerning the nature of fossil remains, Aristotle's views were paramount. He believed that animals could originate from moist earth or the slime of rivers, and this seemed to the people of that period a much simpler way of accounting for the remains of animals in the rocks than the marvellous changes of sea and land otherwise required to explain their presence. Aristotle's opinion was in accordance with the Biblical account of the creation of man out of the dust of the earth, and hence more readily obtained credence.

Theophrastus, a pupil of Aristotle, alludes to fossil fishes found near Heraclea in Pontus, and in Paphlagonia, and says: "They were either developed from fish spawn left behind in the earth, or gone astray from rivers or the sea into cavities of the earth, where they had become petrified." In treating of fossil ivory and bones, the same writer supposed them to be produced by a certain plastic virtue latent in the earth. To this same cause, as we shall see, many later authors attributed the origin of all fossil remains.

Previous to this, Anaximander, the Miletian philosopher, who was born about 610 years before Christ, had expressed essentially the same view. According to both Plutarch and Censorinus, Anaximander taught that fishes, or animals very like fishes, sprang from heated water and earth, and from these animals came the human race; a statement which can hardly be considered as anticipating the modern idea of evolution, as some authors have imagined.

The Romans added but little to the knowledge possessed by the Greeks in regard to fossil remains. Pliny (23-79 A.D.), however, seems to have examined such objects with interest, and in his renowned work on Natural History gave names to several forms. He doubtless borrowed largely from Theophrastus, who wrote about three hundred years before. Among the objects named by Pliny were, "*Bucardia*, like to an ox's heart;" "*Brontia*, resembling the head of a tortoise, supposed to fall in thunderstorms;" "*Glossoptra*, similar to a human tongue which does not grow in the earth, but falls from heaven while the moon is

[1] An Address, delivered before the American Association for the Advancement of Science, at Saratoga, N.Y., August 28, 1879, by Prof. O. C. Marsh, President.

[1] "Metamorphoses," Liber xv., 262.

eclipsed;" "the *Horn of Ammon*, possessing, with a golden colour, the figure of a ram's horn;" *Ceraunia* and *Ombria*, supposed to be thunderbolts; *Ostracites*, resembling the oyster shell; *Spongites*, having the form of sponge; *Phycites*, resembling sea-weed or rushes. He also mentions stones resembling the teeth of hippopotamus; and says that Theophrastus speaks of fossil ivory, both black and white, of bones born in the earth, and of stones bearing the figure of bones.

Tertullian (160 A.D.) mentions instances of the remains of sea animals on the mountains, far from the sea, but uses them as a proof of the general deluge recorded in Scripture.

During the next thirteen or fourteen centuries, fossil remains of animals and plants seem to have attracted so little attention, that few references are made to them by the writers of this period. During these ages of darkness, all departments of knowledge suffered alike, and feeble repetitions of ideas derived from the ancients seem to have been about the only contributions of that period to Natural Science.

Albert the Great (1205-1280 A.D.), the most learned man of his time, mentions that a branch of a tree was found, on which was a bird's nest containing birds, the whole being solid stone. He accounted for this strange phenomenon by the *vis formativa* of Aristotle, an occult force, which, according to the prevalent notions of the time, was capable of forming most of the extraordinary objects discovered in the earth.

Alexander *ab Alexandro*, of Naples, states that he saw, in the mountains of Calabria, a considerable distance from the sea, a variegated hard marble, in which many sea shells but little changed were heaped, forming one mass with the marble.

With the beginning of the sixteenth century, a great impetus was given to the investigation of organic fossils, especially in Italy, where this study really began. The discovery of fossil shells, which abound in this region, now attracted great attention, and a fierce discussion soon arose as to the true nature of these and other remains. The ideas of Aristotle in regard to spontaneous generation, and especially his view of the hidden forces of the earth, which he claimed had power to produce such remains, now for the first time were seriously questioned, although it was not till nearly two centuries later that these doctrines lost their dominant influence.

Leonardo da Vinci, the renowned painter and philosopher, who was born in 1452, strongly opposed the commonly accepted opinions as to the origin of organised fossils. He claimed that the fossil shells under discussion were what they seemed, and had once lived at the bottom of the sea. "You tell me," he says, "that Nature and the influence of the stars have formed these shells in the mountains; then show me a place in the mountains where the stars at the present day make shelly forms of different ages, and of different species in the same place." Again, he says, "In what manner can such a cause account for the petrifactions in the same place of various leaves, sea-weeds, and marine crabs?"

In 1517, excavations in the vicinity of Verona brought to light many curious petrifactions, which led to much speculation as to their nature and origin. Among the various authors who wrote on this subject was Fracastoro, who declared that the fossils once belonged to living animals, which had lived and multiplied where found. He ridiculed the prevailing ideas that the plastic force of the ancients could fashion stones into organic forms. Some writers claimed that these shells had been left by Noah's flood, but to this idea Fracastoro offered a mass of evidence which would now seem conclusive, but which then only aroused bitter hostility. That inundation, he said, was too transient; it consisted mainly of fresh water; and if it had transported shells to great distances, must have scattered them over the surface, not buried them in the interior of mountains.

Conrad Gesner (1516—1565), whose history of animals has been considered the basis of modern zoology, published at Zurich in 1565 a small but important work entitled "De rerum Fossilium, Lapidum, et Gemmarum figuris." It contained a catalogue of the collection of fossils made by John Kentmann. This is the oldest catalogue of fossils with which I am acquainted.

George Agricola (1494—1555) was, according to Cuvier, the first mineralogist who appeared after the revival of learning in Europe. In his great work, "De Re Metalica," published in 1546, he mentions various fossil remains, and says they were produced by a certain *materia pinguis*, or fatty matter, set in fermentation by heat. Some years later Bauhin published a descriptive catalogue of the fossils he had collected in the neighbourhood of Boll, in Würtemberg.[1]

Andrew Mattioli, a distinguished botanist, adopted Agricola's notion as to the origin of organized fossils, but admitted that shells and bones might be turned into stone by being permeated by a "lapidifying juice." Falloppio, the eminent professor of anatomy at Padua, believed that fossil shells were generated by fermentation where they were found; and that the tusks of elephants, dug up near Apulia, were merely earthy concretions. Mercati, in 1574, published figures of the fossil shells preserved in the Museum of the Vatican, but expressed the opinion that they were only stones, that owed their peculiar shapes to the heavenly bodies. Olivi, of Cremona, described the fossils in the Museum at Verona, and considered them all "sports of nature."

Palissy, a French author, in 1580, opposed these views, and is said to have been the first to assert in Paris that fossil shells and fishes had once belonged to marine animals. Fabio Colonna appears to have first pointed out that some of the fossil shells found in Italy were marine, and some terrestrial.

Another peculiar theory discussed in the sixteenth century deserves mention. This was the vegetation theory, especially advocated by Tournefort and Camerarius, both eminent as botanists. These writers believed that the seeds of minerals and fossils were diffused throughout the sea and the earth, and were developed into their peculiar forms by the regular increment of their particles, similar to the formation of crystals. "How could the *Cornu Ammonis*," Tournefort asked, "which is constantly in the figure of a volute, be formed without a seed containing the same structure in the small, as in the larger forms? Who moulded it so artfully, and where are the moulds?" The stalactites which formed in caverns in various parts of the world were also supposed to be proofs of this vegetative growth.

Still another theory has been held at various times, and is not yet entirely forgotten, namely: that the Creator made fossil animals and plants just as they are found in the rocks, in pursuance of a plan beyond our comprehension. This theory has never prevailed among those familiar with scientific facts, and hence needs here no further consideration.

An interest in fossil remains arose in England later than on the Continent; but when attention was directed to them, the first opinions as to their origin were not less fanciful and erroneous than those to which we have already referred. Dr. Plot, in his "Natural History of Oxfordshire," published in 1677, considered the origin of fossil shells and fishes to be due to a "plastic virtue, latent in the earth," as Theophrastus had suggested long before. Lhwyd, in his "Lithophylacii Britannici Ichnographia," published at Oxford in 1699, gives a catalogue of English fossils contained in the Ashmolean Museum. He opposed the *vis plastica* theory, and expressed the opinion that the spawn of fishes and other marine animals had been raised with the vapours from the sea, conveyed inland by clouds, and deposited by rain, had permeated into the interior of the earth, and thus produced the fossil remains we find in the rocks. About this time several important works were published in England by Dr. Martin Lister, which did much to infuse a true knowledge of fossil remains. He gave figures of recent shells side by side with some of the fossil forms, so that the resemblance became at once apparent. The fossil species of shells he called "turbinated and bivalve stones," and adds, "either these were terriginous, or if otherwise, the animals which they so exactly represent have become extinct."

During the seventeenth century there was a considerable advance in the study of fossil remains. The discussions in regard to the nature and origin of these objects had called attention to them, and many collections were now made, especially in Italy, and also in Germany, where a strong interest in this subject had been aroused. Catalogues of these collections were not unfrequently published, and some of them were illustrated with such accurate figures, that many of the species can now be readily recognized. In this century, too, an important step in advance was made by the collection and description of fossils from particular localities and regions, in distinction from general collections of curiosities.

Casper Schwenkfeld, in 1600, published a catalogue of the

[1] "Historia novi et admirabilis Fontis Balneique Bollensis, in Ducata Wirtembergico." Moulbeillard, 1598.

fossils discovered in Silesia; in 1622, a detailed description of the renowned Museum of Calceolarius, of Verona, appeared; and in 1642, a catalogue of Besler's collection; Warmius's catalogue was published in 1652; Spener's in 1663; and Septala's in 1666. A description of the Museum of the King of Denmark was issued in 1669; Cottorp's catalogue in 1674, and that of the renowned Kirscher in 1678. Dr. Grew gave an account in 1687 of the specimens in the Museum of Gresham's College in England; and in 1695, Petiver of London published a catalogue of his very extensive collection. A catalogue by Fred. Lauchmund, on the fossils of Hildesheim, appeared in 1669, and the fossils of Switzerland were described by John Jacob Wagner in 1689. Among similar works were the dissertations of Gyer at Frankfort, and Albertus at Leipsic.

Steno, a Dane, who had been professor of Anatomy at Padua, published, in 1669, one of the most important works of this period.[1] He entered earnestly into the controversy as to the origin of fossil remains, and by dissecting a shark from the Mediterranean, proved that its teeth were identical with some found fossil in Tuscany. He also compared the fossil shells found in Italy with existing species, and pointed out their resemblance. In the same work, Steno expressed some very important views in regard to the different kinds of strata, and their origin, and first placed on record the important fact that the oldest rocks contain no fossils.

Scilla, the Sicilian painter, published in 1670 a work on the fossils of Calabria, well illustrated. He is very severe against those who doubted the organic origin of fossils, but is inclined to consider them relics of the Mosaic deluge.

Another instance of the power of the *lusus naturæ* theory, even at the close of the seventeenth century, deserves mention. In the year 1696, the skeleton of a fossil elephant was dug up at Tonna, near Gotha, in Germany, and was described by William Ernest Tentzel, a teacher in the Gotha Gymnasium. He declared the bones to be the remains of an animal that had lived long before. The Medical Faculty in Gotha, however, considered the subject, and decided officially that this specimen was only a freak of nature.

Beside the authors I have mentioned, there were many others who wrote about fossil remains before the close of the seventeenth century, and took part in the general discussion as to their nature and origin. During the progress of this controversy the most fantastic theories were broached, and stoutly defended, and although refuted from time to time by a few clear-headed men, continually sprang up anew, in the same or modified forms. The influence of Aristotle's views of equivocal generation, and especially the scholastic tendency to disputation, so prevalent during the middle ages, had contributed largely to the retardation of progress, and yet a real advance in knowledge had been made. The long contest in regard to the nature of fossil remains was essentially over, for the more intelligent opinion at the time now acknowledged that these objects were not mere "sports of nature," but had once been endowed with life. At this point, therefore, the first period in the history of palæontology, as I have indicated it, may appropriately end.

It is true that later still, the old exploded errors about the plastic force and fermentation were from time to time revived, as they have been almost to the present day; but learned men, with few exceptions, no longer seriously questioned that fossils were real organisms, as the ancients had once believed. The many collections of fossils that had been brought together, and the illustrated works that had been published about them, were a foundation for greater progress, and, with the eighteenth century, the second period in the history of palæontology began.

The main characteristic of this period was the general belief that *fossil remains were deposited by the Mosaic deluge*. We have seen that this view had already been advanced, but it was not till the beginning of the eighteenth century that it became the prevailing view. This doctrine was strongly opposed by some courageous men, and the discussion on the subject soon became even more bitter than the previous one, as to the nature of fossils.

In this diluvial discussion theologians and laymen alike took part. For nearly a century the former had it all their own way, for the general public, then as now, believed what they were taught. Noah's flood was thought to have been universal, and was the only general catastrophe of which the people of that day had any knowledge or conception.

[1] "De Solido intra Solidum naturaliter Contento."

The scholars among them were of course familiar with the accounts of Deucalion and his ark, in a previous deluge, as we are to-day with similar traditions held by various races of men. The firm belief that the earth and all it contains was created in six days; that all life on the globe was destroyed by the deluge excepting alone what Noah saved; and that the earth and its inhabitants were to be destroyed by fire, was the foundation on which all knowledge of the earth was based. With such fixed opinions, the fossil remains of animals and plants were naturally regarded as relics left by the flood described in Holy Writ. The dominant nature of this belief is seen in nearly all the literature in regard to fossils published at this time, and some of the works which then appeared have become famous on this account.

In 1710, David Büttner published a volume entitled "Rudera Diluvii Testes." He strongly opposed Lhwyd's explanation of the origin of fossils, and referred these objects directly to the flood. The most renowned work, however, of this time, was published at Zurich, in 1726, by Scheuchzer, a physician and naturalist, and professor in the University of Altorf. It bore the title "Homo Diluvii Testis." The specimen upon which this work was based was found at Oeningen, and was regarded as the skeleton of a child destroyed by the deluge. The author recognised in this remarkable fossil, not merely the skeleton, but also portions of the muscles, the liver, and the brain. The same author was fortunate enough to discover, subsequently, near Altorf, two fossil vertebræ, which he at once referred to that "accursed race destroyed by the flood!" These, also, he carefully described and figured in his "Physica Sacra," published at Ulm in 1731. Engravings of both were subsequently given in the "Copper-Bible." Cuvier afterwards examined these interesting relics and pronounced the skeleton of the supposed child to be the remains of a gigantic salamander, and the two vertebræ to be those of an ichthyosaurus!

Another famous book appeared in Germany in the same year in which Scheuchzer's first volume was published. The author was John Bartholomew Adam Beringer, professor at the University of Würtzburg, and his great work[1] indirectly had an important influence upon the investigation of fossil remains. The history of the work is instructive, if only as an indication of the state of knowledge at that date. Prof. Beringer, in accordance with views of his time, had taught his pupils that fossil remains, or "figured stones," as they were called, were mere "sports of nature." Some of his fun-loving students reasoned among themselves, "if nature can make figured stones in sport, why can not we?" Accordingly, from the soft limestone in the neighbouring hills, they carved out figures of marvellous and fantastic forms, and buried them at the localities where the learned professor was accustomed to dig for his fossil treasures. His delight at the discovery of these strange forms encouraged further production, and taxed the ingenuity of these youthful imitators of Nature's secret processes. At last Beringer had a large and unique collection of forms, new to him, and to science, which he determined to publish to the world. After long and patient study, his work appeared, in Latin, dedicated to the reigning prince of the country, and illustrated with twenty-one folio plates. Soon after the book was published, the deception practised upon the credulous professor became known; and in place of the glory he expected from his great undertaking, he received only ridicule and disgrace. He at once endeavoured to repurchase and destroy the volumes already issued, and succeeded so far that few copies of the first edition remain. His small fortune, which had been seriously impaired in bringing out his grand work, was exhausted in the effort to regain what was already issued, as the price rapidly advanced in proportion as fewer copies remained; and, mortified at the failure of his life's work, he died in poverty. It is said that some of his family, dissatisfied with the misfortune brought upon them by this disgrace and the loss of their patrimony, used a remaining copy for the production of a second edition, which met with a large sale, sufficient to repair the previous loss, and restore the family fortune. This work of Beringer's, in the end, exerted an excellent influence upon the dawning science of fossil remains. Observers became more cautious in announcing supposed discoveries, and careful study of natural objects gradually replaced vague hypotheses.

The above works, however, are hardly fair examples of the literature on fossils during this part of the eighteenth century. Scheuchzer had previously published his well-known "Com-

[1] "Lithographia Wirceburgensis, ducentis lapidum figuratorum, a potiori, insectiformium, prodigiosis imaginibus exornata." Wirceburgi, 1726. Edit. II. Francofurti et Lipsiæ. 1767.

plaint and Vindication of the Fishes," illustrated with good plates. Moro, in his work on "Marine Bodies which are found in the Mountains," 1740, showed the effects of volcanic action in elevating strata, and causing faults. Vallisneri had studied with care the marine deposits of Italy. Donati, in 1750, had investigated the Adriatic, and ascertained by soundings that shells and corals were being imbedded in the deposits there, just as they were found in the rocks.

John Gesner's dissertation, "De Petrificatis," published at Leyden in 1758, was a valuable contribution to the science. He enumerated the various kinds of fossils, and the different conditions in which they are found petrified, and stated that some of them, like those at Oeningen, resembled the shells, fishes, and plants of the neighbouring region, while others, such as Ammonites and Belemnites, were either unknown species, or those found only in distant seas. He discusses the structure of the earth at length, and speculates as to the causes of changes in sea and land. He estimates that, at the observed rate of recession of the ocean, to allow the Apennines, whose summits are filled with marine shells, to reach their present height, would have taken about eighty thousand years, a period more than "ten times greater than the age of the universe." He accordingly refers the change to the direct command of the Deity, as related by Moses, that, "The waters should be gathered together in one place, and the dry land appear."

Voltaire (1694-1778) discussed geological questions and the nature of fossils in several of his works, but his published opinions are far from consistent. He ridiculed effectively and justly the cosmogonists of his day, and showed, also, that he knew the true nature of organic remains. Finding, however, that theologians used these objects to confirm the Scriptural account of the deluge, he changed his views, and accounted for fossil shells found in the Alps, by suggesting that they were Eastern species, dropped by the pilgrims on their return from the Holy Land!

Buffon, in 1749, published his important work on Natural History, and included in it his "Theory of the Earth," in which he discussed, with much ability, many points in geology. Soon after the book was published he received an official letter from the Faculty of Theology in Paris, stating that fourteen propositions in his works were reprehensible, and contrary to the creed of the Church. The first objectionable proposition was as follows: "The waters of the sea have produced the mountains and valleys of the land,—the waters of the heavens reducing all to a level, will at last deliver the whole land over to the sea, and the sea successively prevailing over the land, will leave dry new continents like those we inhabit."

Buffon was politely invited by the college to recant, and having no particular desire to be a martyr to science, submitted the following declaration, which he was required to publish in his next work: "I declare that I had no intention to contradict the text of Scripture; that I believe most firmly all therein related about the creation, both as to order of time and matter of fact; and I abandon everything in my book respecting the formation of the earth, and, generally, all which may be contrary to the narration of Moses."

This single instance will suffice to indicate one great obstacle to the advancement of science, even up to the middle of the eighteenth century.

Another important work appeared in France about this time, Bourguet's "Traité des Petrifactions," published in 1758, which is well illustrated with faithful plates. In England, a discourse on earthquakes, by Dr. Robert Hooke, was published in 1705. This author held some views in advance of his time, and maintained that figured stones were "really the several bodies they represent or the mouldings of them petrified, and not, as some have imagined, a *lusus naturæ*, sporting herself in the needless formation of useless things." He anticipates one important conclusion from fossils, when he states that "though it must be very difficult to read them and to raise a chronology out of them, and to state the intervals of time wherein such or such catastrophes and mutations have happened, yet it is not impossible." He also states that fossil turtles and such large Ammonites as are found in Portland, seem to have been the productions of hotter countries, and hence it is necessary to suppose that England once lay under the sea within the torrid zone. He seems to have suspected that some of the fossils of England belonged to extinct species, but thought possibly they might be found living in the bottom of distant oceans.

Dr. Woodward's "Natural History of the Fossils of England" appeared in 1729. This work was based on a systematic collection of fossils which he had brought together, and which he subsequently bequeathed to the University of Cambridge, where it is still preserved, with his arrangement carefully retained. The descriptive part of this work is interesting, but his conclusions are made to coincide strictly with the Scriptural account of the creation and deluge. He had previously stated, in another work, that he believed, "the whole terrestrial globe to have been taken to pieces and dissolved at the flood, and the strata to have settled down from this promiscuous mass." In support of this view, he stated that, "Marine bodies are lodged in the strata according to the order of their gravity, the heavier shells in stones, the lighter in chalk, and so of the rest."[1]

The most important work on fossils published in Germany at this time, was that of George Wolfgang Knorr, which was continued after his death by Walch. This work consisted of four folio volumes, with many plates, and was printed at Nuremberg, 1755-73. A large number of fossils were accurately figured and described, and the work is one of permanent value.[2] A French translation of this work appeared in 1767-78. Burton's "Oryctographie de Bruxelles," 1784, contains figures and descriptions of fossils found in Belgium.

Abraham Gottlieb Werner (1750-1817), Professor of Mineralogy at Freyberg, did much to advance the science of geology, and indirectly, that of fossils. He first indicated the relations of the main formations to each other, and, according to his pupil, Prof. Jameson, first made the highly important observation "that different formations can be discriminated by the petrifactions they contain." Moreover, "that the petrifactions contained in the oldest rocks are very different from any of the species of the present time; that the newer the formation, the more do the remains approach in form to the organic beings of the present creation." Unfortunately, Werner published little, and his doctrines were mainly disseminated by his enthusiastic pupils.

The great contest between the Vulcanists and the Neptunists started at this time, mainly through Werner, whose doctrines led to the controversy. The comparative merits of fire and water, as agencies in the formation of certain rocks, were discussed with a heat and acrimony characteristic of the subject and the time. Werner believed in the aqueous theory, while the igneous theory was especially advocated by Hutton of Edinburgh and his illustrator, Playfair. This discussion resulted in the advancement of descriptive geology, but the study of fossils gained little thereby.

The "Protogæa" of Leibnitz, the great mathematician, published in 1749, about thirty years after his death, was a work of much merit. This author supposed that the earth had gradually cooled from a state of igneous fusion, and was subsequently covered with water. The subsidence of the lower part of the earth; the deposits of sedimentary strata from inundations, and their induration, as well as other changes, followed. All this, he supposed to have been accomplished in a period of six natural days. In the same work Leibnitz shows that he had examined fossils with considerable care.

Linnæus (1707-1778), the famous Swedish botanist, and the founder of the modern system of nomenclature in Natural History, confined his attention almost entirely to the living forms. Although he was familiar with the literature of fossil remains, and had collected them himself, he did not include them in his system of plants and animals, but kept them separate, with the minerals; hence he did little directly to advance this branch of science.

During the last quarter of the eighteenth century, the belief that fossil remains were deposited by the deluge sensibly declined, and the dawn of a new era gradually appeared. Let us pause for a moment here and see what real progress had been made; what foundation had been laid on which to establish a science of fossil remains.

The true nature of these objects had now been clearly determined. They were the remains of animals and plants. Most of them certainly were not the relics of the Mosaic deluge, but had been deposited long before, part in fresh water and part in the sea. Some indicated a mild climate, and some the tropics. That any of these were extinct species, was as yet only suspected. Large collections of fossils had now been made, and valuable catalogues, well illustrated, had been pub-

[1] "Essay towards a Natural History of the Earth." 1695.

[2] "Lapides ex celeberr. viror. sententia diluvii universalis testes, quos in ordines ac species distribuit, suis caloribus expremit, etc." 272 Tab. 1755-73.

lished. Something was known, too, of the geological position of fossils. Steno, long before, had observed that the lowest rocks were without life. Lehmann had shown that above these primitive rocks, and derived from them, were the secondary strata, full of the records of life, and above these were alluvial deposits, which he referred to local floods and the deluge of Noah. Rouelle, Fuchsel, and Odoardi had shed new light on this subject. Werner had distinguished the transition rocks, containing fossil remains, between the primitive and the secondary, while everything above the chalk he grouped together as "The overflowed land." Werner, as we have seen, had done more than this, if we give him the credit his pupils claim for him. He had found that the formations he examined contained each its own peculiar fossils, and from the older to the newer there was a gradual approach to recent forms. William Smith had worked out the same thing in England, and should equally divide the honour of this important discovery.

The greatest advance, however, up to this time was that men now preferred to *observe* rather than to *believe*, and facts were held in greater esteem than vague speculations. With this preparation for future progress, the second period in the history of palæontology, as I have divided it, may appropriately be considered at an end.

Thus far I have said nothing in regard to one branch of my subject, the *methods* of palæontological research, for up to this time, of method there was none. We have seen that those of the ancients who noticed marine shells in the solid rock, called them such, and concluded that they had been left there by the sea. The discovery of fossils led directly to theories of how the earth was formed. Here the progress was slow. Subterranean spirits were supposed to guard faithfully the mysteries of the earth, while above the earth, Authority guarded with still greater power the secrets men in advance of their age sought to know. The dominant idea of the first sixteen centuries of the present era was, that the universe was made for Man. This was the great obstacle to the correct determination of the position of the earth in the universe, and later, of the age of the earth. The contest of astronomy against authority was long and severe, but the victory was at last with science. The contest of geology against the same power followed, and continued almost to our day. The result is still the same. In the early stages of this contest, there was no strife, for science was benumbed by the embrace of superstition and creed, and little could be done till that was cast off. In a superstitious age, when every natural event is referred to a supernatural cause, science cannot live; and often as the sacred fire may be kindled by courageous far-seeing souls, will it be quenched by the dense mist of ignorance around it. Scarcely less fatal to the growth of science is the age of Authority, as the past proves too well. With freedom of thought, came definite knowledge, and certain progress;—but two thousand years was long to wait.

With the opening of the present century, began a new era in Palæontology, which we may here distinguish as the third period in its history. This branch of knowledge became now a science. Method replaced disorder, and systematic study superseded casual observation. For the next half century the advance was continuous and rapid. One characteristic of this period was, *the accurate determination of fossils by comparison with living forms*. This will separate it from the two former epochs. Another distinctive feature of this period was the general belief that *every species, recent and extinct, was a separate creation*.

At the very beginning of the epoch we are now to consider, three names stand out in bold relief: Cuvier, Lamarck, and William Smith. To these men the science of palæontology owes its origin. Cuvier and Lamarck, in France, had all the power which great talent, education, and station could give; William Smith, an English surveyor, was without culture or influence. The last years of the eighteenth century had been spent by each of these men in preparation for his chosen work, and the results were now given to the world. Cuvier laid the foundation of the palæontology of Vertebrate animals; Lamarck, of the Invertebrates; and Smith established the principles of Stratigraphical Palæontology. The investigator of fossils to-day seldom needs to consult earlier authors of the science.

George Cuvier (1769-1832), the most famous naturalist of his time, was led to the study of extinct animals by ascertaining that the remains of fossil elephants he examined were extinct species. "This idea," he says later, "which I announced to the Institute in the month of January 1796, opened to me views entirely new respecting the theory of the earth, and determined me to devote myself to the long researches and to the assiduous labours which have now occupied me for twenty-five years."[1]

It is interesting to note here that in this first investigation of fossil vertebrates, Cuvier employed the same method that gave him such important results in his later researches. Remains of elephants had been known to Europe for centuries, and many authors, from Pliny down to the contemporaries of Cuvier, had written about them. Some had regarded the bones as those of human giants, and those who recognised what they were considered them remains of the elephants imported by Hannibal or the Romans. Cuvier, however, compared the fossils directly with the bones of existing elephants, and proved them to be distinct. The fact that these remains belonged to extinct species was of great importance. In the case of fossil shells, it was difficult to say that any particular form was not living in a distant ocean; but the two species of existing elephants, the Indian and the African, were well known, and there was hardly a possibility that another living one would be found.

It is important to bear in mind, too, that Cuvier's preparations for the study of the remains of animals was far in advance of any of his predecessors. He had devoted himself for years to careful dissections in the various classes of the animal kingdom, and was really the founder of comparative anatomy, as we now understand it. Cuvier investigated the different groups of the whole kingdom with care, and proposed a new classification founded on the plan of structure, which in its main features is the one in use to-day. The first volume of his Comparative Anatomy appeared in 1800, and the work was completed in five volumes in 1805.

Previous to Cuvier, the only general catalogue of animals was contained in Linnæus' "Systema Naturæ." In this work, as we have seen, fossil remains were placed with the minerals, not in their appropriate places among the animals and plants. Cuvier enriched the animal kingdom by the introduction of fossil forms among the living, bringing all together into one comprehensive system. His great work, "Le Règne Animal," appeared in four volumes in 1817, and with its two subsequent editions remains the foundation of modern zoology. Cuvier's classic work on vertebrate fossils—"Recherches sur les Ossemens Fossiles," in four volumes, appeared in 1812-13. Of this work, it is but just to say that it could only have been written by a man of genius, profound knowledge, the greatest industry, and with the most favourable opportunities.

The introduction to this work was the famous "Discourse on the Revolutions of the Surface of the Globe," which has perhaps been as widely read as any other scientific essay. The discovery of fossil bones in the gypsum quarries of Paris, by the workmen, who considered them human remains; the careful study of these relics by Cuvier, and his restorations from them of strange beasts that had lived long before, is a story with which you are all familiar. Cuvier was the first to prove that the earth had been inhabited by a succession of different series of animals, and he believed that those of each period were peculiar to the age in which they lived.

In looking over his work after a lapse of three-quarters of a century, we can now see that Cuvier was wrong on some important points, and failed to realise the direction in which science was rapidly tending. With all his knowledge of the earth, he could not free himself from tradition, and believed in the universality and power of the Mosaic deluge. Again, he refused to admit the evidence brought forward by his distinguished colleagues against the permanence of species, and used all his great influence to crush out the doctrine of evolution, then first proposed. Cuvier's definition of a species, the dominant one for half a century, was as follows: "A species comprehends all the individuals which descend from each other, or from a common parentage, and those which resemble them as much as they do each other."

The law of "Correlation of Structures," as laid down by Cuvier, has been more widely accepted than almost any thing else that bears his name; and yet, although founded in truth, and useful within certain limits, it would certainly lead to serious error if applied widely in the way he proposed.

In his discourse, he sums this law as follows: "A claw, a shoulder blade, a condyle, a leg or arm bone, or any other bone

[1] "Ossemens fossiles." Second Edition, vol. i. p. 178.

separately considered, enables us to discover the description of teeth to which they have belonged; so also reciprocally we may determine the form of the other bones from the teeth. Thus, commencing our investigation by a careful survey of any one bone by itself, a person who is sufficiently master of the laws of organic structure, may, as it were, reconstruct the whole animal to which that bone had belonged."

We know to-day that unknown extinct animals cannot be restored from a single tooth or claw, unless they are very similar to forms already known. Had Cuvier himself applied his methods to many forms from the early tertiary or older formations, he would have failed. If, for instance, he had had before him the disconnected fragments of an eocene tillodont, he would undoubtedly have referred a molar tooth to one of his pachyderms; an incisor tooth to a rodent; and a claw bone to a carnivore. The tooth of a hesperornis would have given him no possible hint of the rest of the skeleton, nor its swimming feet the slightest clue to the ostrich-like sternum or skull. And yet, the earnest belief in his own methods led Cuvier to some of his most important discoveries.

Jean Lamarck (1744-1829), the philosopher and naturalist, a colleague of Cuvier, was a learned botanist before he became a zoologist. His researches on the invertebrate fossils of the Paris Basin, although less striking, were not less important than those of Cuvier on the vertebrates; while the conclusions he derived from them form the basis of modern biology. Lamarck's method of investigation was the same, essentially, as that used by Cuvier, namely: a direct comparison of fossils with living forms. In this way, he soon ascertained that the fossil shells imbedded in the strata beneath Paris were, many of them, extinct species, and those of different strata differed from each other. His first memoir on this subject appeared in 1802,[1] and, with his later works, effected a revolution in conchology. His "System of Invertebrate Animals" appeared the year before, and his famous "Philosophie zoologique," in 1809. In these two works, Lamarck first announced the principles of evolution. In the first volume of his "Natural History of Invertebrate Animals,"[2] he gave his theory in detail; and to-day one can only read with astonishment his far-reaching anticipations of modern science. These views were strongly supported by Geoffroy Saint-Hilaire, but bitterly opposed by Cuvier; and their great contest on this subject is well known.

In looking back from this point of view, the philosophical breadth of Lamarck's conclusions, in comparison with those of Cuvier, is clearly evident. The invertebrates on which Lamarck worked offered less striking evidence of change than the various animals investigated by Cuvier; yet they lead Lamarck directly to evolution, while Cuvier ignored what was before him on this point, and rejected the proof offered by others. Both pursued the same methods, and had an abundance of material on which to work, yet the facts observed induced Cuvier to believe in catastrophes; and Lamarck, in the uniform course of nature. Cuvier declared species to be permanent; Lamarck, that they were descended from others. Both men stand in the first rank in science; but Lamarck was the prophetic genius, half a century in advance of his time.

(*To be continued.*)

FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE French Association for the Progress of Science has taken a bold step and decided that its session for 1881 will take place in Algiers. To avoid the numerous inconveniences of the strong heat which prevails all over Algeria in the month of August, it has been decided that the meeting should be held in April, during the Easter recess.

This happy result of the deliberations must be attributed to the personal exertions of M. Albert Grévy, the brother of the President of the French Republic, who holds the post of Civil Governor-General of Algeria.

It is supposed that the new scientific establishment whose formation has been decreed this year, will be formally inaugurated on this occasion, and a scientific movement of some importance will take place in the colony.

The *Akhbar* announced a few days back that a geographical society is being organised in Algiers.

[1] "Mémoire sur les Fossiles des Environs de Paris." 1802-6.

[2] "Histoire naturelle des Animaux sans Vertèbres." 7 vols. Paris, 1815-1822. Second Edition. 11 vols. 1835-1845.

In the meantime a number of representatives headed by Algerian senators and deputies will make a tour of exploration during the month of October. They will start at the end of September, as we announced some weeks ago. They will witness an agricultural and horticultural exhibition, which is to be held at Bone, for the whole of Algeria and Tunisia, and which will be held in Algiers in 1881.

The most successful lecture this year at Montpellier, was organised by the Languedocian Society of Geography. MM. Soleillet, Brau de Saint Pol Lias, Director of the Sumatra Exploring Company, and other explorers or intending explorers, appeared before the public on that occasion. M. Rabaut, the President of the Society of Geography of Marseilles, and the commercial agent for the Sultan of Zanzibar, gave most interesting details of the several explorations at present going on in that part of the Dark Continent.

The lecture on the progress of electricity was given by M. Denayrouze, of Jablochkoff candle notoriety. The speaker tried to show that Jamin's candle ought to be superior to the light which is spreading so largely in Paris and in London.

Another lecture was delivered by M. Barral, Perpetual Secretary of the National Society of Agriculture, on the necessity of using Rhone water for irrigation. There is, however, a variety of opinion on this subject, commercial people being really opposed to the irrigation scheme for the reason that it would diminish the quantity of water necessary for navigation, especially as it is intended to submerge vines in order to save them from phylloxera, the plague of the country.

A very interesting display took place in the Polygon, of the destroying power of modern methods of warfare, as practised by French engineers of the 2nd Regiment, which is garrisoned in Montpellier. It cannot be said that science is alien to the use of dynamite and electric sparks for such purposes, but it is the first time that warfare has been considered as being really within the limits of a scientific association.

Two of the most interesting excursions were devoted to agriculture—one to the experimental grounds established by M. Marey, one of the most active correspondents of the Academy of Sciences, with a view to destroy phylloxera, and the other to the School of Agriculture directed by M. Camille Saint Pierre. This school, established with the help of the General Council only a few years back, has already reached a high point of prosperity. Its reputation is so high in the Mediterranean regions that the Greek Government is sending there a number of pupils at its own expense.

The Sericicultural Station has been placed under the direction of M. Maillot, a pupil of M. Pasteur at the Normal School of Paris, who has already instructed ninety-two persons in the difficult art of observing silkworms' eggs with microscopes.

At the Viticultural Station American vines, insecticide, and all the proposed means of destroying phylloxera are being studied.

All the pupils of the Normal School for public teachers, are attending a course of lectures in that establishment, so that the teachers of the young Herault peasants will have a scientific knowledge of new methods proposed for scientific agriculture of the region.

SCIENTIFIC SERIALS

American Journal of Science and Arts, August.—This number opens with the first portion of a paper by Mr. Upham, on terminal moraines of the North American ice-sheet.—Prof. Kimball describes experiments with regard to the effects of magnetisation on the tenacity of iron and on the flexure of a soft iron bar. *Inter alia*, he proves that a soft iron bar has its tenacity increased about nine-tenths of 1 per cent. by magnetising it to saturation.—Prof. Hilgard calls attention to some points in connection with the loess of the Mississippi valley, which seems to render the Æolian hypothesis untenable regarding that and similar deposits elsewhere; the hypothesis, viz., that the true loess is always a subaërial deposit, formed in a dry central region, and that it owes its structure to the formative influence of a steppe vegetation.—Dr. Cutter describes his method of micro-photography with Tolles's $\frac{1}{75}$-inch objective.—Prof. Peirce demonstrates the value of M. Faye's proposal of a method of swinging pendulums for the determination of gravity, and Mr. Hodges offers some considerations on the size of molecules, arising out of the conversion of water into steam, and the combining effect of platinum on hydrogen and oxygen.—Among other topics treated are the geology of Virginia, the discovery of a new group of carboni-

ferous rocks in South-Eastern Ohio, and the Laramie group of Southern Colorado and Northern New Mexico.

Journal of the Franklin Institute, August.—The following may here be noted :—Committee Report on the Fairbank's testing machine.—A new method of constructing index plates for gear cutters, by Prof. Sweet.—A new genus in telephones, by Prof. Dolbear.—On the use of determining slag densities in smelting, by Mr. MacFarlane.

Bulletin de l'Académie Royale des Sciences (de Belgique), No. 6, 1879.—Besides the paper of M. Montigny on the colour in scintillation of stars (elsewhere noticed), we note here an account of a new method, by M. Bruylants, for preparing hydriodic and hydrobromic acids, viz., adding iodine and bromine to the terpene contained abundantly in balsam of copaiba, and then detaching them under the influence of heat in the state of the corresponding acids.—The physiology of the muscles and nerves of the lobster is elucidated by MM. Fredericq and Vandevelde, who show that the only difference from superior animals is in the velocity of the nervous influence, this being, in the lobster, only 6 metres per second. Further, it is diminished considerably in the termination of the motor-nerves.—Mr. Macleod communicates a histological paper on the Harder gland in the domestic duck; and M. Schleicher writes on the living cartilaginous cell, the protoplasm of which he finds to consist of two different substances, one nearly liquid and homogeneous, the other, solid elements endowed with contractility (the nucleus is similarly formed).—M. Dubois describes some new birds.

No. 7.—M. Montigny here brings forward evidence that the principal star γ of Andromedes is subject to changes of colour, which are very probably periodic.—M. Plateau finds, in two notes by Brewster, confirmation of his views on the nature of irradiation.—A paper by MM. Masquelin and Swaen treats of the first phases of development of the maternal placenta in the rabbit, and M. Folie writes on some theorems relative to surfaces of superior order.

Journal de Physique, August.—On the temperature of the polar extremities of carbons producing the electric light, by M. Rossetti.—On Ampère's formula, by M. Jamin.—Researches on the compressibility of gases, by M. Cailletet.—M. Faber's speaking machine, by M. Gariel.

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. xii. fasc. xiv.—On the problem of subdivision of the electric light, by Prof. Ferrini.—Observations of Swift's comet at the Observatory of Brera, by Prof. Schiaparelli.—Study on some crania of Araucanians and Pampas in the National Museum of Anthropology of Florence, by Dr. Riccardi.—Results of observations on the diurnal period of magnetic declination during 1872-77, at the observatory of Brera in Milan, by Dr. Rajna.—On the Mascart electrometer, by Dr. Maggi and S. Ascoli.—Experiments on the capillarity of water, by Dr. Poloni.

Fasc. xv.—On the transformation of the 11th order of elliptic functions, by S. Klein.—On special corpuscles (psorosperms) of man, by Dr. Grassi.—On the application of the dynamometer in operations of lithotrity, by Prof. Scarenzio.—Meteorological observations at the Observatory of Brera, in Milan, in 1878, by S. Frisiani.—Contributions to a study of the lias fauna of Lombardy, by Dr. Parona.

THE *Jahrbuch der k.k. geologischen Reichsanstalt* (Vienna, ii., April to June) contains an elaborate treatise by C. M. Paul and Dr. E. Tietze, entitled "New Studies on the Sandstone-zone of the Carpathian Mountains." The remainder of the part is taken up by a petrographical study on the granite of Predazzo, by A. Sigmund, followed by some geological and petrographical notes on the older eruptive and stratified rocks of the Middle and Eastern Alps, by Dr. Guido Stache and Conrad von John. The latter paper is the second communication these gentlemen have made on the subject, and treats specially of the Cevedale district as the distribution district of older dioritic porphyrites. It is accompanied by four well-drawn plates.—The *Abhandlungen* of the same Society (vol. xii. Heft 1) contain the first part of an excellent treatise by R. Hoernes and M. Auinger on the Gasteropoda of the marine deposits of the first and second miocene Mediterranean stages in the Austro-Hungarian Empire. The species here described belong all to the genus *Conus*, and are well reproduced on six magnificent plates. Thus we have illustrations of Chelyconus, Rhizoconus, Lithoconus, Dendroconus, Liptoconus, and Stephanoconus, representing some fifty-two different varieties.

SOCIETIES AND ACADEMIES

LONDON

Entomological Society, September 3.—J. Jenner Weir, F.L.S., F.Z.S., treasurer, in the chair.—Mr. Philip B. Mason exhibited specimens of *Harpalus oblongiusculus*, Dej., taken at Portland, and also, on behalf of Mr. Gameys, specimens of *Euplectus ambiguus*, Reich., found in flood refuse at Repton.—Miss E. A. Ormerod read "Notes on the Prevention of Cane-borers."—Mr. Jenner Weir exhibited a pair, male and female, of *Cicada montana*, Scop., taken at the New Forest, Hampshire.—M. Ch. Oberthur communicated the following paper : "Observations sur les Lépidoptères des Îles Sangir et Descriptions de quelques Espèces nouvelles."

PARIS

Academy of Sciences, September 8.—M. Daubrée in the chair.—The following papers were read :—On the mean value of numerical coefficients in a skew determinant of order infinitely great, by Prof. Sylvester.—Pathological predisposition and immunity; influence of origin or of race on the aptitude of animals of ovine species to contract splenic disease, by M. Chauveau. Algerian sheep seem to enjoy immunity from this disorder. M. Chauveau selected nine from different lots of authentic origin in the Lyons market (to which large numbers are imported). Notwithstanding repeated inoculation (three and five times), none of them showed multiplication of the *Bacillus anthracis*, characteristic of the disease. On the other hand, French sheep and rabbits all succumbed after the first inoculation. M. Chauveau urges the importance of this question of special immunity.—The President expressed the lively satisfaction of the Academy at M. Nordenskjöld's return.—On the causes of reinvasion of phylloxerised vines, by M. de Laffitte.—On the same subject, by M. Cauvy.—On the compounds of hydracids with ammonia, by M. Maumené. Some observations on the *rôle* of insects during the flowering of *Arum crinitum*, Ait., by M. Schnetzler. Of the flies attracted by the fetid odour of this Arum, those most pressed to lay, deposit their eggs at the bottom of the spathe; then, prevented escaping by the viscous hairs at the entrance, they die. Others, less pressed to lay, are attracted by the glandular hairs on the spadix, which lead them, like the degrees of a scale, to the stamens. There, walking on the anthers, they liberate the pollen, and remounting the spadix in the direction of the hairs, they fly off to lay their eggs in another spathe, at the bottom of which they deposit on the stigmata the pollen brought from the stamens of another individual; then, imprisoned in their turn, they die. The purple red hairs covering a good deal of the interior surface of the spathe probably contain an acid which, like that exuding from the hairs of Drosera, may contribute to transformation of the azotised matters of insects into matters absorbable by the spathe.

GÖTTINGEN

Royal Academy of Sciences, May 3.—On sums of the greatest whole numbers in arithmetical series, by Herr Zeller.—On the galvanic resistance of gas-carbon, by Herr Auerbach.

June 4.—New relations between the class numbers of the quadratic form of negative determinants, by Herr Gierster.

June 14.—On endogenous formation of normal lateral shoots in the genera Rytiphlœa, Vidalia, and Amansia, by Herr Falkenberg.

CONTENTS

eir,
son
at
of
.—
ne-
of
—
er-
de

he
of
ely
m-
als
u.
M.
in
ot-
of
c-
nd
au
he
M.
yl-
M.
M.
he
es
to
ed
sa
x,
s.
d
ff
y
of
e.
e
g
of
e

e
e

e

s
r